512

JOHN COLLINS
ENGINEERS, P.C. TRAFFIC • TRANSPORTATION ENGINEERS
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February 1, 2002

Mr. Neil Novesky, Director
Community Economic Development
City of Middletown - City Hall
16 James Street
Middletown, NY 10940

Re: Highland Avenue Corridor Traffic Evaluation
City of Middletown, NY

Dear Mr. Novesky:

As requested, John Collins Engineers, P.C. has completed our preliminary evaluation of traffic conditions along the Highland Avenue corridor between Route 211 and Wisner Avenue. The purpose of the evaluation was to collect and analyze information regarding existing traffic volumes, vehicle speeds and vehicle classification as well as other operating characteristics including accidents and pedestrian considerations. The following sections describe the data collection and analysis procedures as well as our preliminary results and recommendations.

1. STUDY AREA DESCRIPTION (Figure No. 1)

The study area included Highland Avenue between Route 211 and Wisner Avenue and included the evaluation of several specific intersections along the corridor. Figure No. 1 identifies the study area roadways.

2. COLLECTION OF EXISTING CONDITIONS DATA
(Figures No. 2, 3, 4, and Tables No. 1 and 2)

a. Traffic Volume, Speed and Classification Data

The initial work effort included the collection of both machine and manual traffic counts along Highland Avenue.

The machine counts included several locations along Highland Avenue, where vehicle mix, vehicle speed and volume data was recorded for typical weekday periods during the period from October 22, 2001 through October 26, 2001. The machine counts included 24 hour observations which were recorded on 15 minute intervals throughout the day. Figure No. 1 shows the location of the machine counts and Tables No. 1 and 2 summarize by time of day the vehicle mix and volume/speed data, respectively. Appendix "A" contains copies of the figures and Appendix "B" contains copies of the tables.

In addition, manual turning movement counts were conducted at six area locations. These included the following intersections:

- Highland Avenue and Prospect Street
- Highland Avenue and Jay Street
- Highland Avenue and Sunset
- Highland Avenue and Wisner Avenue
- Highland Avenue and Route 211
- Commonwealth Avenue and Wisner Avenue

The turning movement traffic counts included weekday morning, mid-day and afternoon peak hours at each of the intersections. Figures No. 2, 3, and 4 show the 2001 Existing Traffic Volumes for the weekday Peak AM Highway Hour (7:30-8:30 AM), weekday Peak Mid-day Hour (2:30-3:30 PM) and weekday Peak PM Highway Hour (4:45-5:45 PM), respectively.

A review of the data indicates that the total peak hour traffic volumes along Highland Avenue are between 700 and 850 vehicles per hour with an Average Daily Traffic (ADT) of over 9,000 vehicles. Also, during peak periods the vehicle classification is primarily passenger vehicles

however, during off-peak periods, some trucks were found utilizing the Highland Avenue corridor.

The speed observations indicated that the average travel speeds was approximately 35 mph and the 85th percentile speed was approximately 40 miles per hour.

b. Vehicle Licence Plate Surveys and Travel Time Surveys

In order to identify traffic patterns in the area and to better define the origin and destinations of vehicles along Highland Avenue, a limited licence plate survey was conducted during peak periods. This survey indicated that a significant portion of the traffic was traffic using the Highland Avenue Corridor to connect from Route 211 to Wisner Avenue or vice versa.

Travel time surveys were also conducted during peak periods along Highland Avenue and along North Street to determine current travel times along these roadways. Highland Avenue was found to be significantly faster than using North Street.

c. Accident Data

Accident data was collected from the New York State Department of Motor Vehicles and was reviewed relative to the type number and other characteristics of accidents. Copies of the data are presented in Appendix "G".

3. EXISTING CONDITIONS - DATA ANALYSIS (Table No. 3)

The existing conditions data was summarized and presented in tabular form with respect to vehicular speeds and other statistics. In addition, to determine actual intersection operating conditions, capacity analyses were conducted at each of the key intersections for each of the peak hours utilizing the procedures contained in the year 2000 Highway Capacity Manual.

Description Of Analysis

In order to determine existing and future traffic operating conditions at the study area intersections, it was necessary to perform capacity analyses see Appendix "C". The following is a brief description of the analysis method utilized in this report:

- Signalized Intersection Capacity Analysis

  The capacity analysis for a signalized intersection was performed in accordance with the procedure described in the 2000 Highway Capacity Manual, published by the Transportation Research Board. The terminology used in identifying traffic flow conditions is Levels of Service. A Level of Service "A" represents the best condition and a Level of Service "F" represents the worst condition. A Level of Service "C" is generally used as a design standard while a Level of Service "D" is acceptable during peak periods. A Level of Service "E" represents an operation near capacity. In order to identify an intersection's Level of Service the average amount of vehicle delay is computed for each approach to the intersection as well as for the overall intersection.

- Unsignalized Intersection Capacity Analysis

  The unsignalized intersection capacity analysis method utilized in this report was also performed in accordance with the procedures described in the 2000 Highway Capacity Manual. The procedure is based on total elapsed time from when a vehicle stops at the end of the queue until the vehicle departs from the stop line. The average total delay for any particular critical movement is a function of the service rate or capacity of the approach and the degree of saturation. In order to identify the Level of Service, the average amount of vehicle delay is computed for each critical movement to the intersection as well as for the overall intersection.

Additional information concerning signalized and unsignalized Levels of Service can be found in Appendix "D" of this report.

The capacity analysis results for all locations are summarized in Table No. 3. As can be seen from a review of this table, based on standard traffic engineering criteria, the intersections operate at acceptable Levels of Service during peak periods.

The main intersections along Highland Avenue were also reviewed relative to the need for possible signalization and or other traffic control measures. A review of the intersections of Highland Avenue and Prospect Street indicates that the traffic volumes required for traffic signal warrants would not be met for the required periods at this location (See Table W-1). Similar results were found for the intersections at Sunset Street and at Jay Street.

4. SUMMARY OF PRELIMINARY IMPROVEMENT ALTERNATIVES (Table A and Drawing CP-1)

Based on a review of the existing traffic volumes, the results of the capacity analysis and other analysis procedures, the following is a summary of possible improvement alternatives which could be pursued to control travel speeds along this corridor and also provide improved pedestrian safety but still provide efficient overall traffic conditions. The improvements include possible geometric, signing and other traffic "calming" measures which could be implemented to improve overall conditions. Some of the typical methods used for traffic calming are summarized in Table A.

The following is a summary of some of the traffic calming measures which should be considered in order to help control travel speeds along the Highland Avenue corridor. These measures should be completed in conformance with NYSDOT design standards which are referenced in the attached document.

1. Upgrade the crosswalk pavement markings with high visibility markings as indicated in the NYS MUTCD. At a

minimum these should be provided at the intersection of Highland Avenue and Prospect Street as well as Highland Avenue with Sunset Street.

2. Install speed limit and speed zone signing as per NYS MUTCD along this roadway for both northbound and southbound traffic.

3. The Highland Avenue roadway pavement width is currently in excess of 40 feet. Certain areas are available for parking especially near the higher intensity uses including the nursing home, funeral home, Elks Club, etc. When these facilities are in use, parking occurs along the roadway, however, during much of the peak daytime hours, much of this area does not have any on street parking which results in very wide travel lanes on Highland Avenue which in turn encourages higher speeds. One of the following alternates could be implemented to narrow the effective roadway travelway which should help reduce speeds:

   - Development of "pocket parking areas" with extended island areas.

   - Provision of mid-block speed humps. Two potential locations would be between Sunset and Jay Street and the other in the area near Prospect Street.

   - Alternate speed enforcement, i.e., placement of portable radar units to advise motorists of their travel speeds. If speed continues to be an issue, additional speed enforcement could be undertaken by the police department.

   - Textured pavement treatment with a contrasting pavement type to delineate the pedestrian crosswalks.

- Implementation of some traffic signal improvements along the North Street Corridor to improve travel speeds and reduce amount of diverted traffic to Highland Avenue during peak periods. These are identified in the Middletown traffic study and are primarily signal efficiency improvements.

- Creation of a mini-roundabout. This could be a mid-block location, however, would have to be carefully looked at relative to adjoining setbacks of residential building etc.

In addition to the above alternatives, several other observations and recommendations for signing and striping on the area roadways were identified. These should be considered regardless of the above and are as follows:

1. At the intersection of Prospect Street/YMCA access, the YMCA exit drive is currently uncontrolled. Consideration should be given to providing an "All Way Stop" sign at this intersection together with the provision of painted crosswalks.

2. At the intersection of Sunset Street and Commonwealth, there is an existing four way stop, however, it is not identified as an "All Way Stop" intersection. This should be added to the intersection signing.

3. At several of the area intersections, painted stop bars should also be added.

4. The crosswalks along Highland Avenue and or at it's adjacent cross streets should be upgraded to meet current DOT delineation patterns and "drop curbs" should be added at the crosswalks of the main intersections of Highland and Prospect and Highland and Sunset.

5. At the intersection of Wisner Avenue and Rockwell Avenue, consideration should be given to modifying the "yield" sign control to a "stop" sign control.

6. At the intersection of Commonwealth Avenue and Wisner Avenue consideration should be given to the installation of a "stop" sign on the Commonwealth approach.

7. Lastly, many of the roadways in this area have been recently paved with good pavement condition, coordination relative to striping should be undertaken to ensure that all roadways are properly marked.

Figure No. CP-1 conceptually shows the locations where some of the improvements could be implemented.

In summary, since many of these possible traffic calming measures may involve additional curbing, maintenance and/or enforcement issues, they should be initially discussed with the City Public Works Department, the Police Department and Highway Maintenance Department. Furthermore, while the traffic calming measures should help reduce speed along Highland Avenue, more extreme measures such as street closings or other alternates for Highland Avenue would not be considered appropriate since they might divert more traffic to Commonwealth and Watkins which are narrower in width and thus, additional through traffic should not be encouraged.

At this time we would suggest meeting with you to discuss these items further and determine which, if any, areas should be pursued in more detail. After we meet, we would then be in a position to present our preliminary results to the Common Council or the designated Task Force.

Sincerely,
JOHN COLLINS ENGINEERS, P.C.

Philip J. Grealy, Ph.D., P.E.

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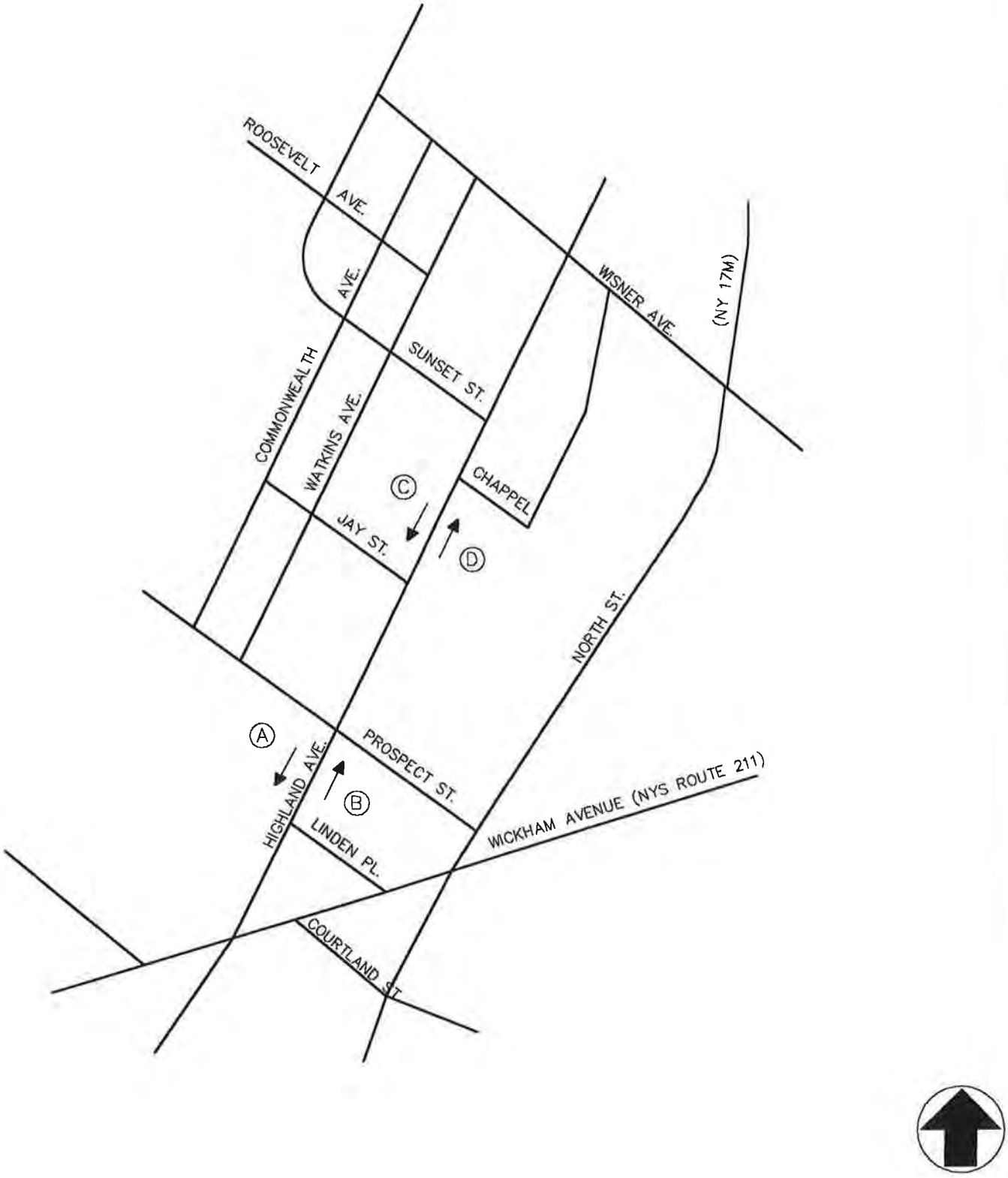
APPENDIX "A"

FIGURES



(X) = MACHINE LOCATION

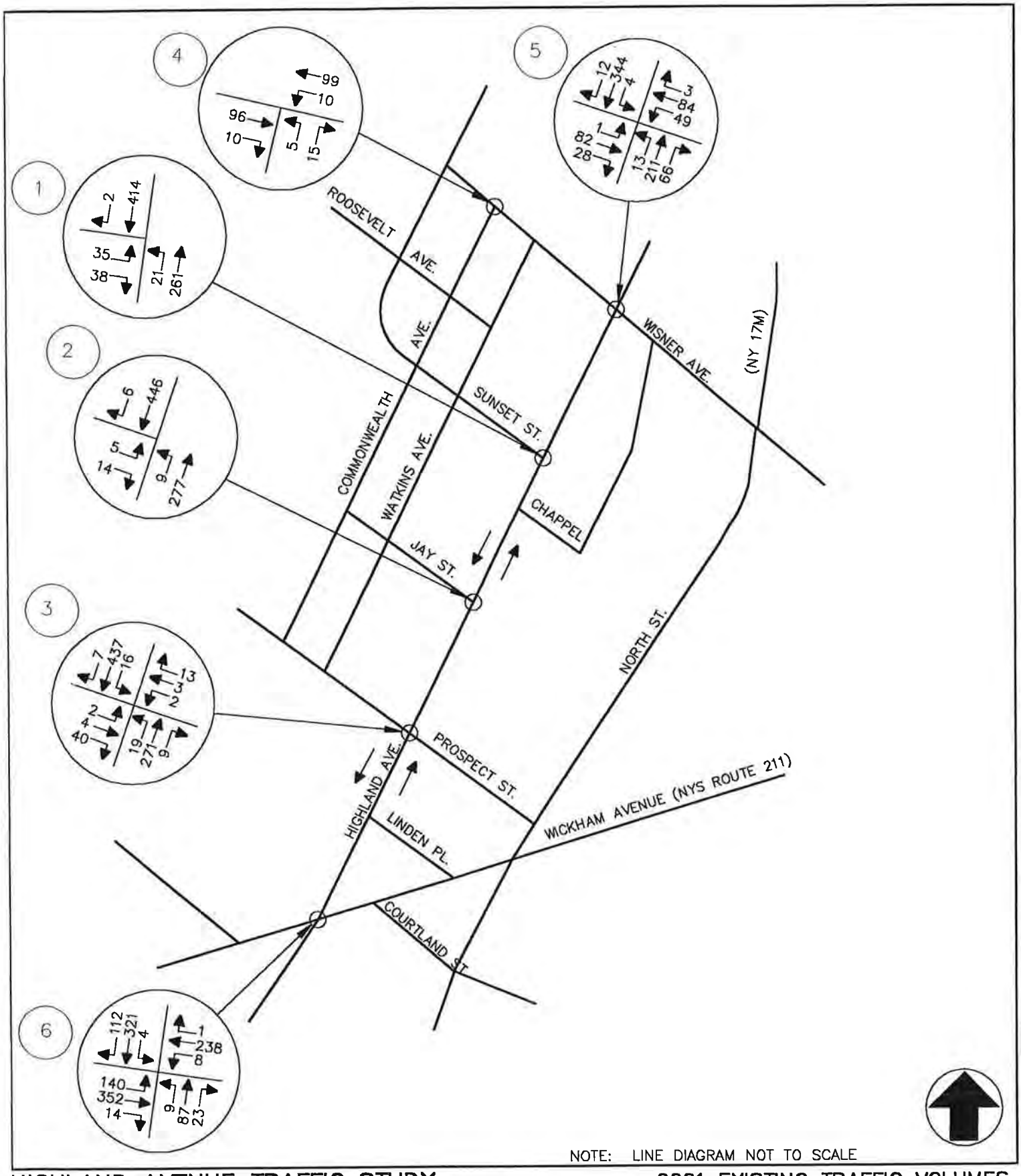
NOTE: LINE DIAGRAM NOT TO SCALE

HIGHLAND AVENUE TRAFFIC STUDY
MIDDLETOWN, NEW YORK

MACHINE COUNT LOCATIONS

JOHN COLLINS ENGINEERS, P.C.
HAWTHORNE, NEW YORK

PROJECT NO. 512 DATE: NOV. 2001 FIG. NO. 1



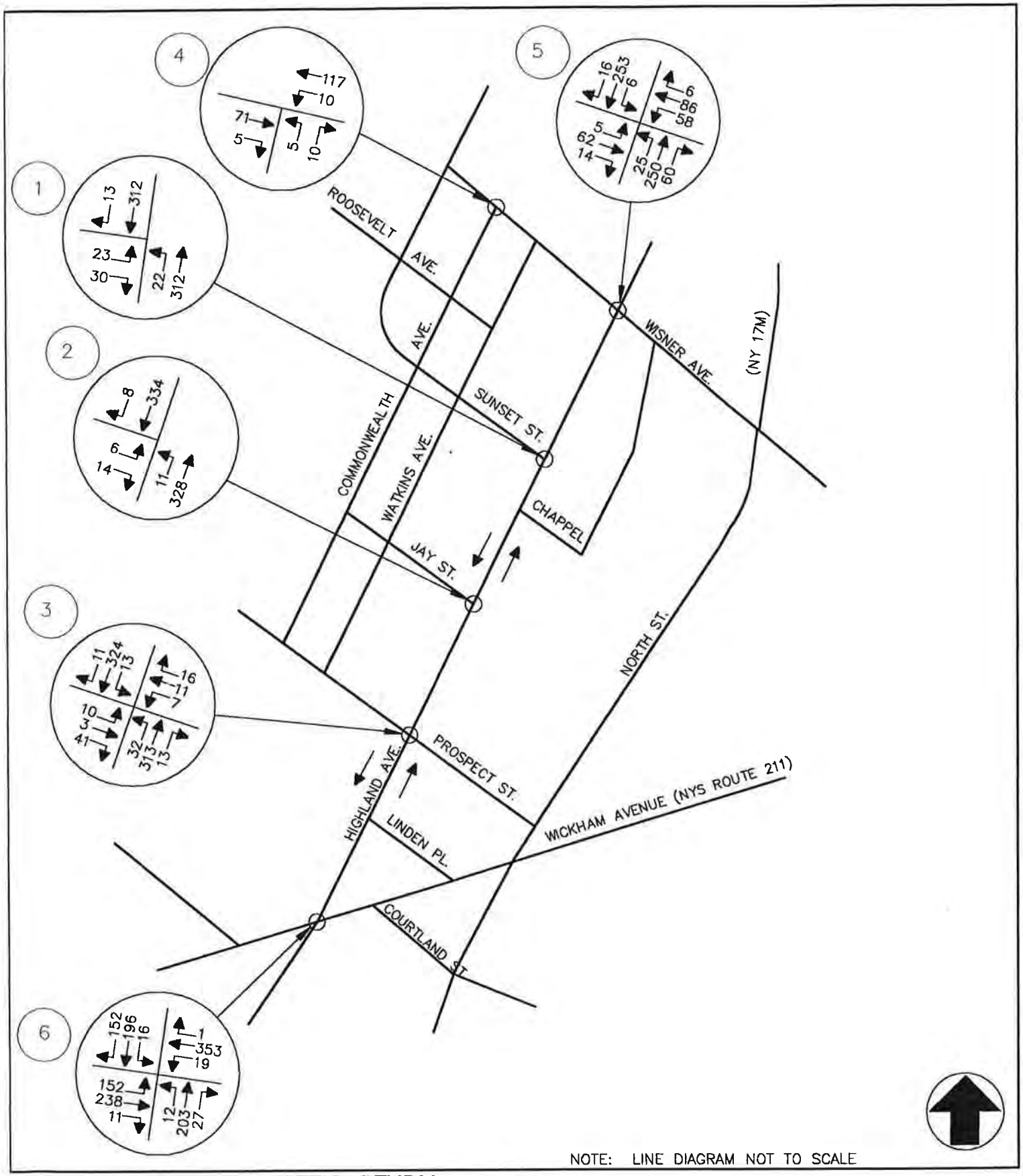
NOTE: LINE DIAGRAM NOT TO SCALE

HIGHLAND AVENUE TRAFFIC STUDY
MIDDLETOWN, NEW YORK

2001 EXISTING TRAFFIC VOLUMES
PEAK AM HOUR

JOHN COLLINS ENGINEERS, P.C.
HAWTHORNE, NEW YORK

PROJECT NO. 512 DATE: NOV. 2001 FIG. NO. 2



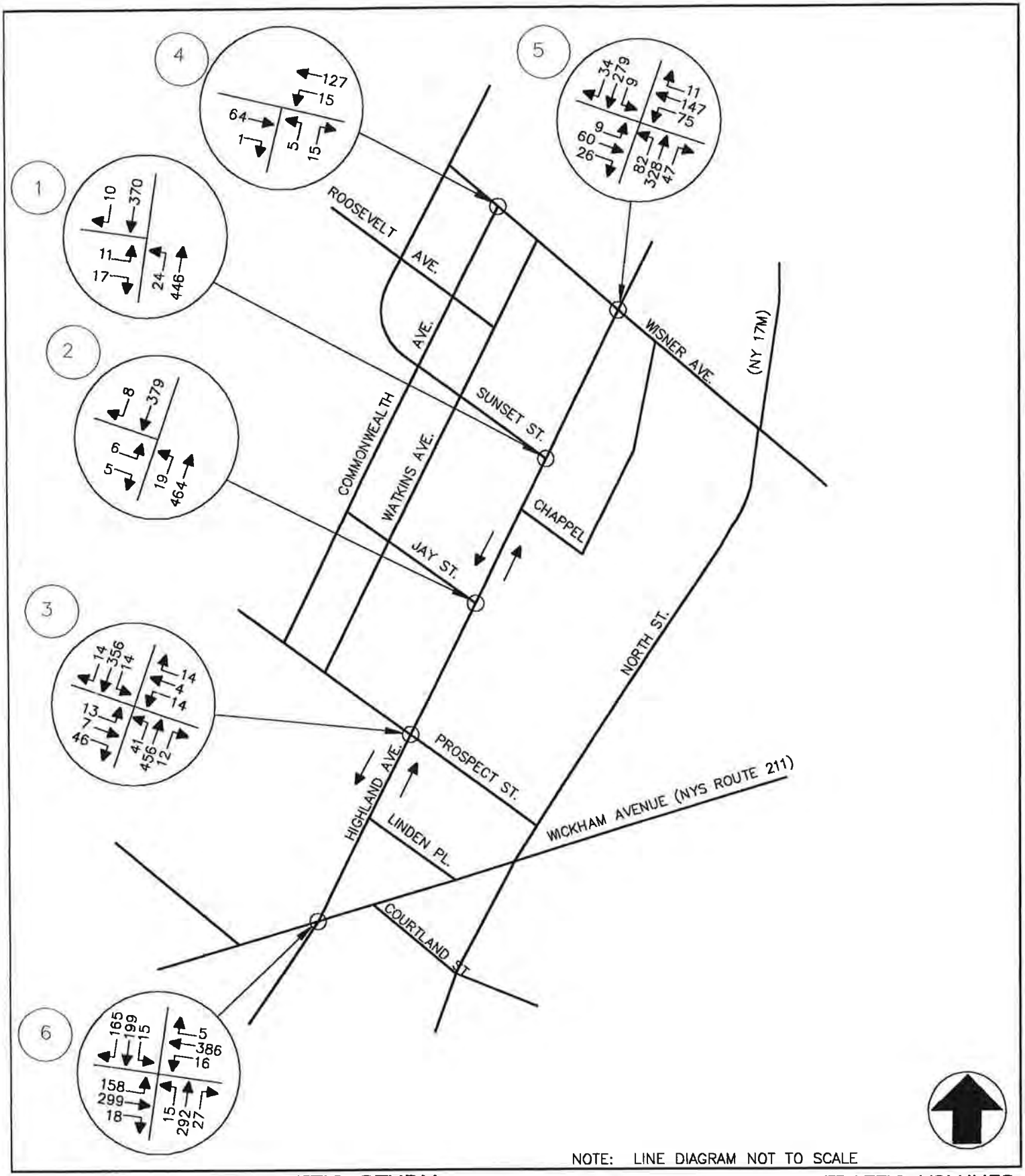
NOTE: LINE DIAGRAM NOT TO SCALE

HIGHLAND AVENUE TRAFFIC STUDY
MIDDLETOWN, NEW YORK

2001 EXISTING TRAFFIC VOLUMES
PEAK MD HOUR

JOHN COLLINS ENGINEERS, P.C.
HAWTHORNE, NEW YORK

PROJECT NO. 512 DATE: NOV. 2001 FIG. NO. 3



NOTE: LINE DIAGRAM NOT TO SCALE

HIGHLAND AVENUE TRAFFIC STUDY
MIDDLETOWN, NEW YORK

2001 EXISTING TRAFFIC VOLUMES
PEAK PM HOUR

JOHN COLLINS ENGINEERS, P.C.
HAWTHORNE, NEW YORK

PROJECT NO. 512 DATE: NOV. 2001 FIG. NO. 4

APPENDIX "B"

TABLES

TABLE W-1

SIGNAL WARRANTS ANALYSIS

(Based on Manual of Uniform Traffic Control Devices, New York State DOT)

INTERSECTION DATA

MAJOR STREET: HIGHLAND AVE.
MINOR STREET: PROSPECT ST.

LOCATION: MIDDLETOWN, NY

DATE: 2/6/2002

VOLUME BASIS.....

CONDITION .....

CHARACTERISTICS

Number Of Lanes For Moving Traffic By Approach
Major Street (Excluding Auxiliary Lanes) = 1
Minor Street (Including Auxiliary Lanes) = 1

Speed
85 % Speed >= 40 mph (Y or N)-----> N

Median
Raised median 4' or more in width on major street (Y or N)?------> N

Population
Community < 10,000 (Y or N)------> N

TIME	VOLUMES			WARRANT 1		WARRANT 2		WARRANT 3		WARRANT MET?			
Hour Begin	Major Street	Minor Street	Major Peds	Major Street	Minor Street	Major Street	Minor Street	Major Street	Major Peds	1	2	3	7
12:00 AM	0	0	0	500	150	750	75	600	150	NO	NO	NO	NO
01:00 AM	0	0	0	500	150	750	75	600	150	NO	NO	NO	NO
02:00 AM	0	0	0	500	150	750	75	600	150	NO	NO	NO	NO
03:00 AM	0	0	0	500	150	750	75	600	150	NO	NO	NO	NO
04:00 AM	0	0	0	500	150	750	75	600	150	NO	NO	NO	NO
05:00 AM	0	0	0	500	150	750	75	600	150	NO	NO	NO	NO
06:00 AM	0	0	0	500	150	750	75	600	150	NO	NO	NO	NO
07:00 AM	621	32	0	500	150	750	75	600	150	NO	NO	NO	NO
08:00 AM	568	50	0	500	150	750	75	600	150	NO	NO	NO	NO
09:00 AM	529	33	0	500	150	750	75	600	150	NO	NO	NO	NO
10:00 AM	526	30	0	500	150	750	75	600	150	NO	NO	NO	NO
11:00 AM	493	31	0	500	150	750	75	600	150	NO	NO	NO	NO
12:00 PM	581	35	0	500	150	750	75	600	150	NO	NO	NO	NO
01:00 PM	681	40	0	500	150	750	75	600	150	NO	NO	NO	NO
02:00 PM	750	43	0	500	150	750	75	600	150	NO	NO	NO	NO
03:00 PM	757	64	0	500	150	750	75	600	150	NO	NO	NO	NO
04:00 PM	655	44	0	500	150	750	75	600	150	NO	NO	NO	NO
05:00 PM	537	63	0	500	150	750	75	600	150	NO	NO	NO	NO
06:00 PM	528	56	0	500	150	750	75	600	150	NO	NO	NO	NO
07:00 PM	0	0	0	500	150	750	75	600	150	NO	NO	NO	NO
08:00 PM	0	0	0	500	150	750	75	600	150	NO	NO	NO	NO
09:00 PM	0	0	0	500	150	750	75	600	150	NO	NO	NO	NO
10:00 PM	0	0	0	500	150	750	75	600	150	NO	NO	NO	NO
11:00 PM	0	0	0	500	150	750	75	600	150	NO	NO	NO	NO

NOTE : s = highest volume on major street crosswalk

TOTAL HOURS MEETING WARRANTS	0	0	0	0
TOTAL HOURS NEEDED TO SATISFY	8	8	8	8

MINIMUM VEHICULAR VOLUME	WARRANT 1: NOT SATISFIED -- NO SIGNAL
INTERRUPTION OF CONTINUOUS TRAFFIC	WARRANT 2: NOT SATISFIED -- NO SIGNAL
MINIMUM PEDESTRIAN VOLUME	WARRANT 3: NOT SATISFIED -- NO SIGNAL
COMBINATION OF WARRANTS	WARRANT 7: NOT SATISFIED -- NO SIGNAL

TABLE NO. 1

Weather : Machine A (SB)
Counted by:
Board # : VOLUME DATA
Other :

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 512000000111
Start Date: 10/22/2001
File I.D. : 512L1V
Page : 1

Street name :HIGHLAND BETWEEN Cross street:PROSPECT ST. & LINDEN PL. A to B

Begin Time	10/22 Int.	Mon. Total	10/23 Int.	Tues. Total	10/24 Int.	Wed. Total	10/25 Int.	Thur. Total	10/26 Int.	Fri. Total	Weekday Avg.	10/27	Sat. Total	10/28 Int.	Sun. Total
12:00 am		*		*		14		13		16	14		*		*
01:00		*		*		5		5		12	7		*		*
02:00		*		*		6		12		17	12		*		*
03:00		*		*		9		7		13	10		*		*
04:00		*		*		22		32		34	29		*		*
05:00		*		*		111		101		97	103		*		*
06:00		*		*		289		289		280	286		*		*
07:00		*		*		504		466		460	477		*		*
08:00		*		*		324		355		337	339		*		*
09:00		*		*		254		237		279	257		*		*
10:00		*		*		290		300		320	303		*		*
11:00		*		*		279		300		2	194		*		*
12:00 pm		*		*		270		261		*	266		*		*
01:00		*		*		333		325		*	329		*		*
02:00		*		376		416		419		*	404		*		*
03:00		*		373		386		332		*	364		*		*
04:00		*		348		395		343		*	362		*		*
05:00		*		333		388		368		*	363		*		*
06:00		*		268		285		273		*	275		*		*
07:00		*		184		171		183		*	179		*		*
08:00		*		124		152		114		*	130		*		*
09:00		*		71		82		88		*	80		*		*
10:00		*		73		64		66		*	68		*		*
11:00		*		27		40		36		*	34		*		*
Totals		0		2177		5089		4925		1867	4885		0		0
Avg. WkDay		.0%		44.5%		104.1%		100.8%		38.2%			.0%		.0%
AM Peaks						07:00		07:00		07:00	07:00				
Volume						504		466		460	477				
PM Peaks				02:00		02:00		02:00			02:00				
Volume				376		416		419			404				

ADTs

TABLE NO. 2

Weather : Machine D (NB)
Counted by:
Board # :
Other :

VOLUME DATA

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 000000051205
Start Date: 10/22/2001
File I.D. : 512L5V
Page : 1

Street name :HIGHLAND NB BETWEEN Cross street:SUNSET ST & JAY ST A to B

Begin Time	10/22 Int.	Mon. Total	10/23 Int.	Tues. Total	10/24 Int.	Wed. Total	10/25 Int.	Thur. Total	10/26 Int.	Fri. Total	Weekday Avg.	10/27	Sat. Total	10/28 Int.	Sun. Total
12:00 am		*		*		16		10		11	12		*		*
01:00		*		*		9		3		12	8		*		*
02:00		*		*		6		5		8	6		*		*
03:00		*		*		12		13		15	13		*		*
04:00		*		*		32		29		29	30		*		*
05:00		*		*		113		117		115	115		*		*
06:00		*		*		204		197		164	188		*		*
07:00		*		*		235		251		238	241		*		*
08:00		*		*		193		230		197	207		*		*
09:00		*		*		187		207		192	195		*		*
10:00		*		*		276		268		61	202		*		*
11:00		*		*		278		219		*	248		*		*
12:00 pm		*		*		247		246		*	246		*		*
01:00		*		*		315		290		*	302		*		*
02:00		*		*		387		381		*	384		*		*
03:00		*		369		401		352		*	374		*		*
04:00		*		395		394		398		*	396		*		*
05:00		*		263		277		276		*	272		*		*
06:00		*		215		209		195		*	206		*		*
07:00		*		170		199		155		*	175		*		*
08:00		*		156		175		149		*	160		*		*
09:00		*		68		78		81		*	76		*		*
10:00		*		57		48		45		*	50		*		*
11:00		*		26		44		24		*	31		*		*
Totals		0		1719		4335		4141		1042	4137		0		0
Avg. WkDay		.0%		41.5%		104.7%		100.1%		25.1%			.0%		.0%
AM Peaks						11:00		10:00		07:00	11:00				
Volume						278		268		238	248				
PM Peaks				04:00		03:00		04:00			04:00				
Volume				395		401		398			396				

ADTs

TABLE NO. 3

LEVEL OF SERVICE SUMMARY TABLE

			2001 EXISTING		
			AM	MD	PM
1	SUNSET ST. & HIGHLAND AVE.	**UNSIGNALIZED**			
		EB	B[14.7]	B[13.0]	B[14.2]
		NB	A[8.3]	A[8.0]	A[8.2]
2	JAY ST. & HIGHLAND AVE.	**UNSIGNALIZED**			
		EB	B[12.6]	B[11.8]	C[15.1]
		NB	A[8.4]	A[8.1]	A[8.2]
3	PROSPECT ST. & HIGHLAND AVE.	**UNSIGNALIZED**			
		EB	B[12.8]	B[13.1]	C[16.3]
		WB	B[12.5]	C[15.2]	C[21.2]
		NB	A[8.4]	A[8.1]	A[8.2]
		SB	A[7.9]	A[8.0]	A[8.5]
4	WISNER AVE. & COMMONWEALTH AVE.	**UNSIGNALIZED**			
		WB	A[7.4]	A[7.4]	A[7.4]
		NB	A[9.1]	A[9.1]	A[9.0]
5	WISNER AVE. & HIGHLAND AVE.	**SIGNALIZED**			
		EB	A[7.0]	A[6.8]	A[6.9]
		WB	A[7.2]	A[7.3]	A[7.8]
		NB	C[22.5]	C[24.8]	F[113.6]
		SB	C[24.4]	C[21.6]	C[23.3]
		OVERALL	B[19.0]	B[18.9]	E[55.9]
6	NY ROUTE 211 & HIGHLAND AVE.	**SIGNALIZED**			
		EB	D[44.6]	D[49.8]	F[104.5]
		WB	B[15.0]	B[17.1]	B[18.0]
		NB	B[11.2]	B[12.1]	B[13.0]
		SB	B[19.1]	B[15.2]	B[15.7]
		OVERALL	C[27.5]	C[25.2]	D[42.2]

NOTES:

THE ABOVE REPRESENTS THE LEVEL OF SERVICE AND VEHICLE DELAY IN SECONDS, C [16.2], , FOR EACH APPROACH AS WELL AS FOR THE OVERALL INTERSECTION.

TABLE A

CATEGORIES OF TRAFFIC CALMING

TRAFFIC CALMING

- Volume Control
  - Full and Partial Road Closures
  - Forced turns islands
  - Diverters
  - Median Barriers
- Speed Control
  - Active Measures
    - Construction Measures
      - Neckdowns
      - Chokers
      - Pedestrian Refuge Islands
    - Deflections Measures
      - Roundabouts/Mini-Roundabouts
      - Chicanes
      - Center Island
      - Alternate Side Parking
      - Speed Humps
      - Raised Crosswalks
      - Raised Intersections
  - Passive
    - Bicycle Lanes
    - Narrowed Lanes
    - Special Signs
    - On-Street Parking
    - Rumble Strips
    - Textured Pavement
    - Street Scape

Posting 25 mph Speed Limits/Radar Warnings

Description: This option involves posting 25 mph speed limit or radar warning signs on the street to regulate the speed of traffic. Costs are typically $200 per sign installation if a pole has to be erected.

Positive Aspects:

- Low cost installation that are popular with residents.
- Reduces traffic speeds if backed up with regular enforcement.

Negative Aspects:

- High potential for violation when not enforced.
- Increases cost of sign maintenance.

Radar Trailer

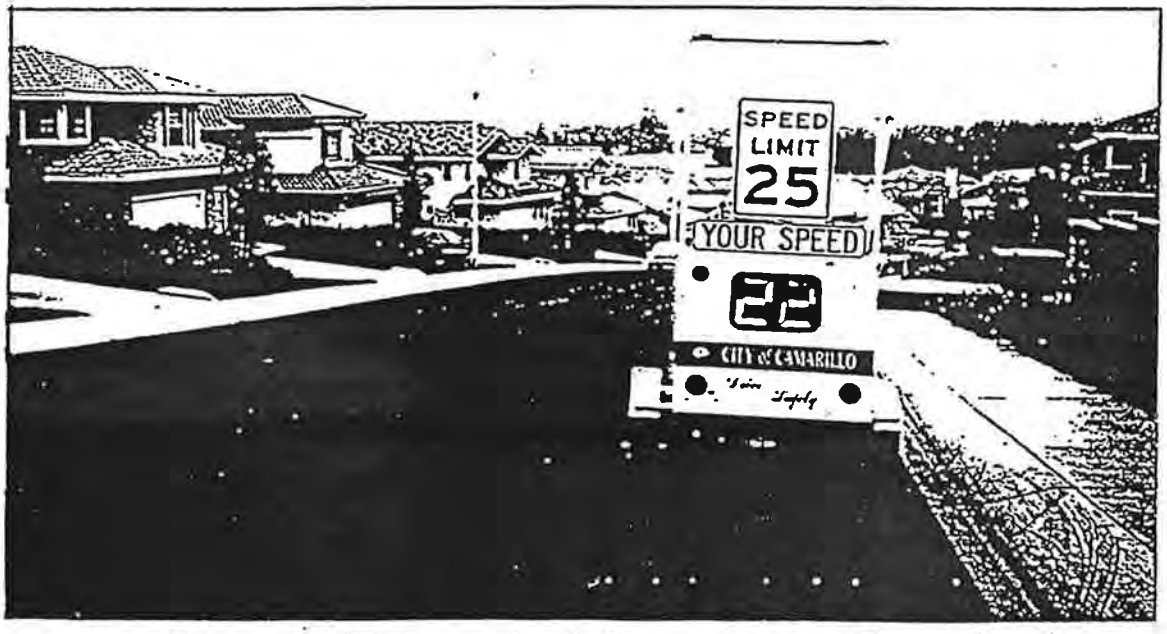
Description: A portable radar speed meter capable of measuring vehicle speed graphically and displaying the speed of the motorist.

Positive Aspects:

- Speeds may be reduced during short intervals where the radar trailer is located.
- An effective public relations and educational tool.

Negative Aspects:

- Not an enforcement tool.
- Not effective on multi-lane roadways that have significant traffic volumes. In these cases there is limited ability to differentiate between more than one approaching vehicle.



Speed Humps

Description: Mounds of paving material placed across a roadway for the purpose of causing motorists to reduce their operating speed while driving on the roadway.

Positive Aspects:

- Reduces speed.
- Can cause traffic to shift to arterial system and no longer cut through the neighborhood.

Negative Aspects:

- Can cause traffic to shift to parallel residential streets.
- Affects emergency response times
- Contents of vehicles can be jarred.
- Increase in noise adjacent to hump.

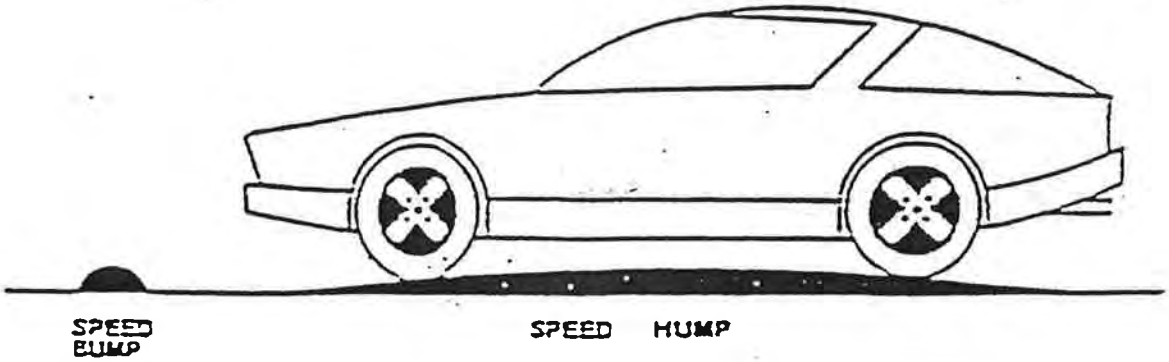


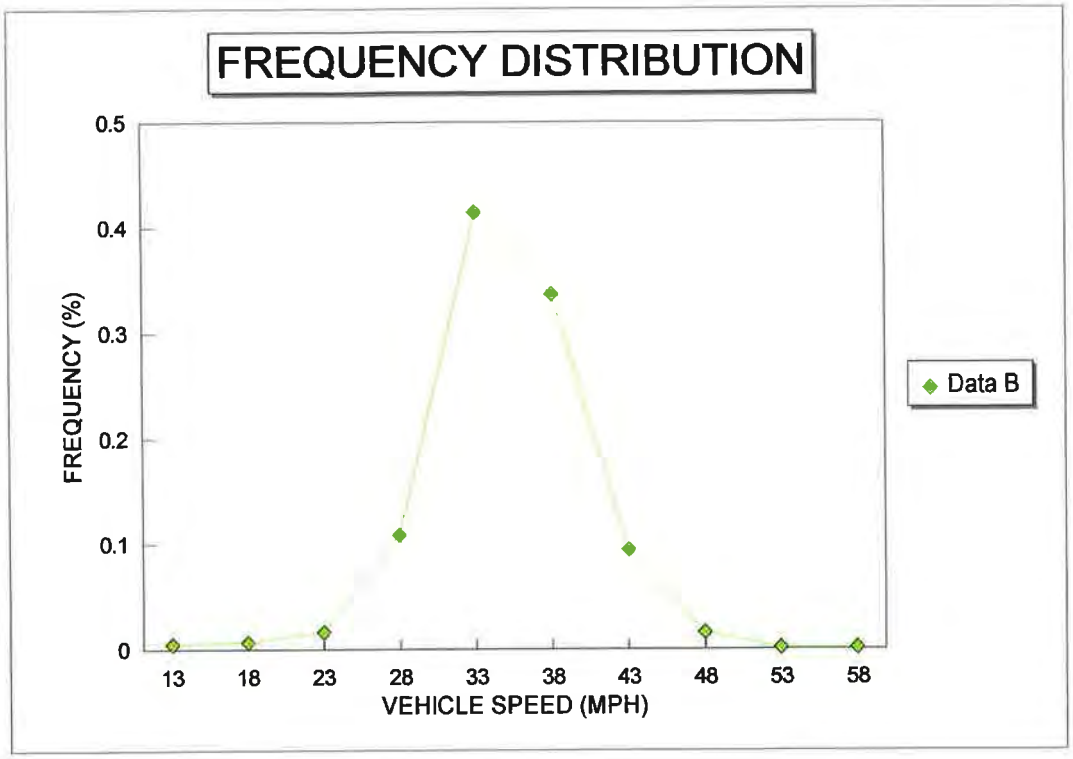
TABLE S-1

FREQUENCY DISTRIBUTION TABLE
HIGHLAND AVE. SB
MACHINE LOCATION C

SPEED CLASS MPH	CLASS MID-VALUE Ui	CLASS FREQ. Fi	FiUi	% OBSERV IN CLASS	CUM % of ALL OBSERV
0-15	13	55	715	0.47%	0.47%
16-20	18	76	1368	0.64%	1.11%
21-25	23	195	4485	1.65%	2.76%
26-30	28	1292	36176	10.93%	13.69%
31-35	33	4888	161304	41.36%	55.05%
36-40	38	3971	150898	33.60%	88.65%
41-45	43	1121	48203	9.48%	98.13%
46-50	48	187	8976	1.58%	99.71%
51-55	53	18	954	0.15%	99.86%
56 >	58	16	928	0.14%	100.00%
		11819	414007	100.00%	

TABLE S-1

TOTAL WEEKLY SPEED DISTRIBUTION TABLES
HIGHLAND AVE. SB
MACHINE LOCATION C



1146.65

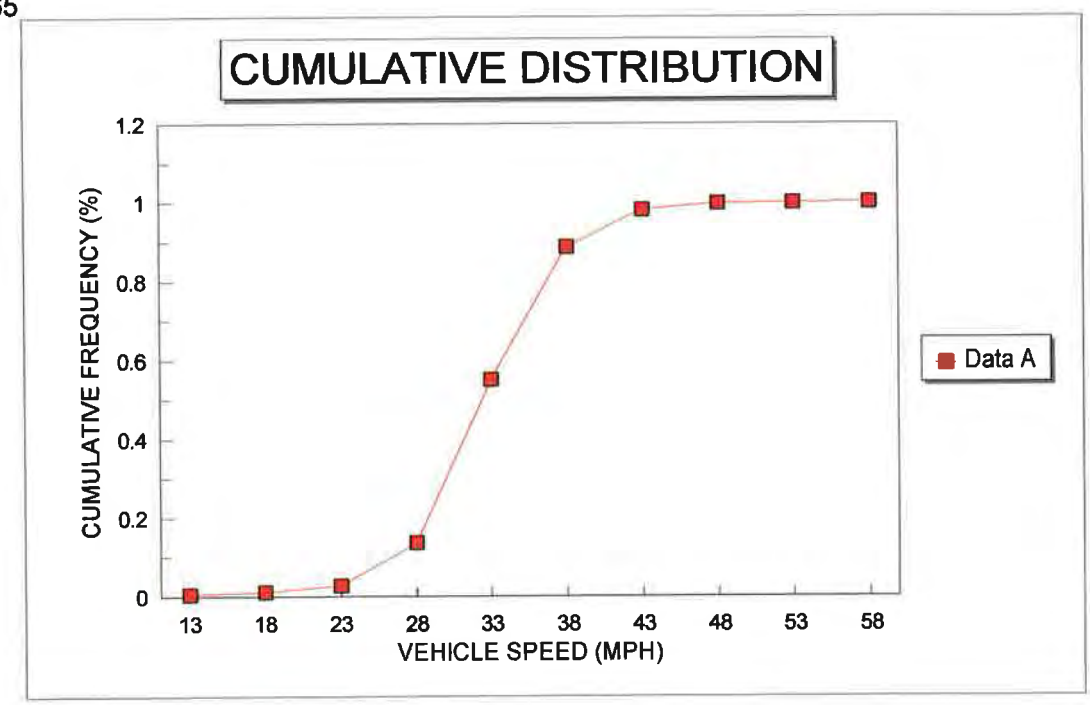


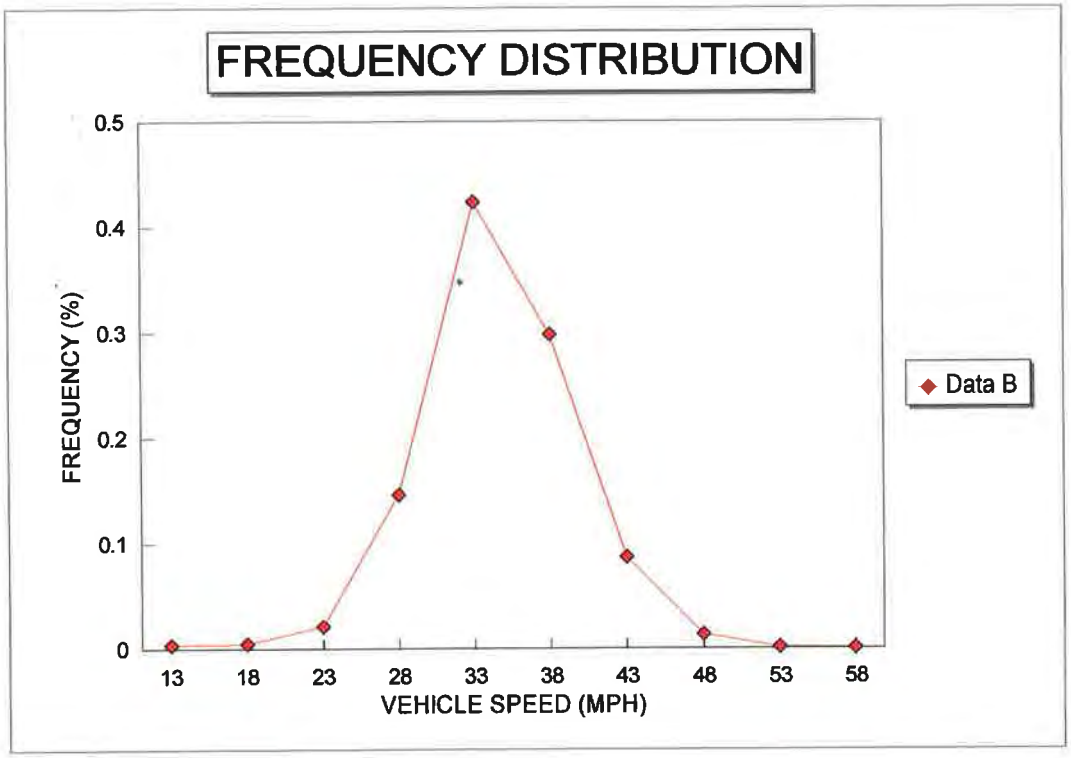
TABLE S-2

FREQUENCY DISTRIBUTION TABLE
HIGHLAND AVE. NB
MACHINE LOCATION D

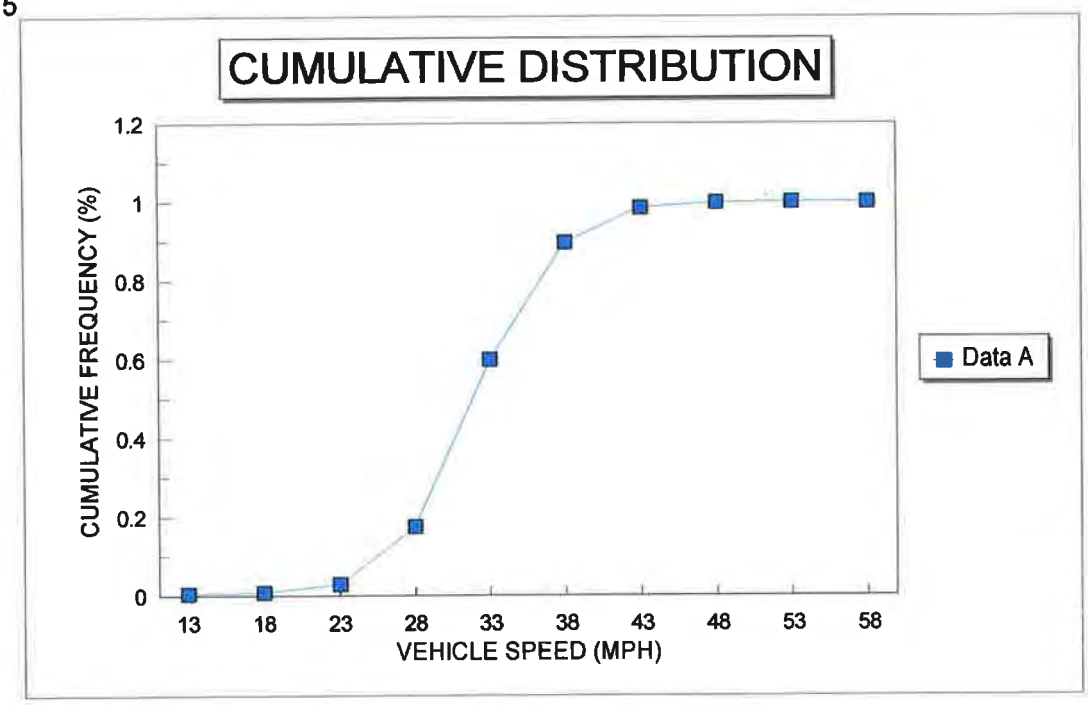
SPEED CLASS MPH	CLASS MID-VALUE Ui	CLASS FREQ. Fi	FiUi	% OBSERV IN CLASS	CUM % of ALL OBSERV
0-15	13	42	546	0.37%	0.37%
16-20	18	53	954	0.47%	0.85%
21-25	23	238	5474	2.12%	2.97%
26-30	28	1635	45780	14.59%	17.56%
31-35	33	4749	156717	42.38%	59.94%
36-40	38	3340	126920	29.80%	89.74%
41-45	43	974	41882	8.69%	98.43%
46-50	48	150	7200	1.34%	99.77%
51-55	53	17	901	0.15%	99.92%
56 >	58	9	522	0.08%	100.00%
		11207	386896	100.00%	

TABLE S-2

TOTAL WEEKLY SPEED DISTRIBUTION TABLES
HIGHLAND AVE. NB
MACHINE LOCATION D



1073.15



APPENDIX "C"

CAPACITY ANALYSIS

HCS2000: Unsignalized Intersections Release 4.1

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 11/9/01
Analysis Time Period:
Intersection: 2001 EXISTING TRAFFIC VOLUMES
Jurisdiction:
Analysis Year:
Project ID: 512AMEX1
East/West Street: SUNSET ST.
North/South Street: HIGHLAND AVE.

Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	21	261			414	2
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Hourly Flow Rate, HFR	23	290			460	2
Percent Heavy Vehicles	0	--	--		--	--
Median Type	Undivided					
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				35		38
Peak Hour Factor, PHF				0.90		0.90
Hourly Flow Rate, HFR				38		42
Percent Heavy Vehicles				0		0
Percent Grade (%)		0			0	
Median Storage						
Flared Approach: Exists?					No	
Storage						
RT Channelized?						
Lanes				0		0
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	23						80	
C(m) (vph)	1110						450	
v/c	0.02						0.18	
95% queue length	0.06						0.64	
Control Delay	8.3						14.7	
LOS	A						B	
Approach Delay							14.7	
Approach LOS							B	

HCS2000: Unsignalized Intersections Release 4.1

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 11/9/01
Analysis Time Period:
Intersection: 2001 EXISTING TRAFFIC VOLUMES
Jurisdiction:
Analysis Year:
Project ID: 512MDEX1
East/West Street: SUNSET ST.
North/South Street: HIGHLAND AVE.

Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	22	312			312	13
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Hourly Flow Rate, HFR	24	346			346	14
Percent Heavy Vehicles	0	--	--		--	--
Median Type	Undivided					
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				23		30
Peak Hour Factor, PHF				0.90		0.90
Hourly Flow Rate, HFR				25		33
Percent Heavy Vehicles				0		0
Percent Grade (%)		0			0	
Median Storage						
Flared Approach: Exists?					No	
Storage						
RT Channelized?						
Lanes				0		0
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	24						58	
C(m) (vph)	1210						508	
v/c	0.02						0.11	
95% queue length	0.06						0.38	
Control Delay	8.0						13.0	
LOS	A						B	
Approach Delay							13.0	
Approach LOS							B	

HCS2000: Unsignalized Intersections Release 4.1

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 11/9/01
Analysis Time Period:
Intersection: 2001 EXISTING TRAFFIC VOLUMES
Jurisdiction:
Analysis Year:
Project ID: 512PMEX1
East/West Street: SUNSET ST.
North/South Street: HIGHLAND AVE.

Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	24	446			370	10
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Hourly Flow Rate, HFR	26	495			411	11
Percent Heavy Vehicles	0	--	--		--	--
Median Type	Undivided					
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				11		17
Peak Hour Factor, PHF				0.90		0.90
Hourly Flow Rate, HFR				12		18
Percent Heavy Vehicles				0		0
Percent Grade (%)		0			0	
Median Storage						
Flared Approach: Exists?					No	
Storage						
RT Channelized?						
Lanes				0		0
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	26						30	
C(m) (vph)	1148						423	
v/c	0.02						0.07	
95% queue length	0.07						0.23	
Control Delay	8.2						14.2	
LOS	A						B	
Approach Delay							14.2	
Approach LOS							B	

HCS2000: Unsignalized Intersections Release 4.1

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 11/9/01
Analysis Time Period:
Intersection: 2001 EXISTING TRAFFIC VOLUMES
Jurisdiction:
Analysis Year:
Project ID: 512AMEX2
East/West Street: JAY ST.
North/South Street: HIGHLAND AVE.

Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	9	277			446	6
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Hourly Flow Rate, HFR	10	307			495	6
Percent Heavy Vehicles	0	--	--		--	--
Median Type	Undivided					
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				5		14
Peak Hour Factor, PHF				0.90		0.90
Hourly Flow Rate, HFR				5		15
Percent Heavy Vehicles				0		0
Percent Grade (%)		0			0	
Median Storage						
Flared Approach: Exists?					No	
Storage						
RT Channelized?						
Lanes				0		0
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	10						20	
C(m) (vph)	1074						492	
v/c	0.01						0.04	
95% queue length	0.03						0.13	
Control Delay	8.4						12.6	
LOS	A						B	
Approach Delay							12.6	
Approach LOS							B	

HCS2000: Unsignalized Intersections Release 4.1

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 11/9/01
Analysis Time Period:
Intersection: 2001 EXISTING TRAFFIC VOLUMES
Jurisdiction:
Analysis Year:
Project ID: 512MDEX2
East/West Street: JAY ST.
North/South Street: HIGHLAND AVE.

Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	11	328			334	8
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Hourly Flow Rate, HFR	12	364			371	8
Percent Heavy Vehicles	0	--	--		--	--
Median Type	Undivided					
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				6		14
Peak Hour Factor, PHF				0.90		0.90
Hourly Flow Rate, HFR				6		15
Percent Heavy Vehicles				0		0
Percent Grade (%)		0			0	
Median Storage						
Flared Approach: Exists?					No	
Storage						
RT Channelized?						
Lanes				0		0
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	12						21	
C(m) (vph)	1191						547	
v/c	0.01						0.04	
95% queue length	0.03						0.12	
Control Delay	8.1						11.8	
LOS	A						B	
Approach Delay							11.8	
Approach LOS							B	

HCS2000: Unsignalized Intersections Release 4.1

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 11/9/01
Analysis Time Period:
Intersection: 2001 EXISTING TRAFFIC VOLUMES
Jurisdiction:
Analysis Year:
Project ID: 512PMEX2
East/West Street: JAY ST.
North/South Street: HIGHLAND AVE.

Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	19	464			379	8
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Hourly Flow Rate, HFR	21	515			421	8
Percent Heavy Vehicles	0	--	--		--	--
Median Type	Undivided					
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				6		5
Peak Hour Factor, PHF				0.90		0.90
Hourly Flow Rate, HFR				6		5
Percent Heavy Vehicles				0		0
Percent Grade (%)		0			0	
Median Storage						
Flared Approach: Exists?					No	
Storage						
RT Channelized?						
Lanes				0		0
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	21						11	
C(m) (vph)	1141						369	
v/c	0.02						0.03	
95% queue length	0.06						0.09	
Control Delay	8.2						15.1	
LOS	A						C	
Approach Delay							15.1	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 1/25/02
Analysis Time Period:
Intersection: 2001 EXISTING TRAFFIC VOLUMES
Jurisdiction:
Analysis Year:
Project ID: 512AMEX3
East/West Street: PROSPECT ST.
North/South Street: HIGHLAND AVE.

Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	19	271	9	16	437	7
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR	21	301	10	17	485	7
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	2	3	13	2	4	40
Peak Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR	2	3	14	2	4	44
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Median Storage						
Flared Approach: Exists?		No			No	
Storage						
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	21	17		19			50	
C(m) (vph)	1082	1261		496			512	
v/c	0.02	0.01		0.04			0.10	
95% queue length	0.06	0.04		0.12			0.32	
Control Delay	8.4	7.9		12.5			12.8	
LOS	A	A		B			B	
Approach Delay				12.5			12.8	
Approach LOS				B			B	

HCS2000: Unsignalized Intersections Release 4.1

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 11/9/01
Analysis Time Period:
Intersection: 2001 EXISTING TRAFFIC VOLUMES
Jurisdiction:
Analysis Year:
Project ID: 512MDEX3
East/West Street: PROSPECT ST.
North/South Street: HIGHLAND AVE.

Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	32	313	13	13	324	11
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR	35	347	14	14	360	12
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	7	11	16	10	3	41
Peak Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR	7	12	17	11	3	45
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Median Storage						
Flared Approach: Exists?		No			No	
Storage						
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	35	14		36			59	
C(m) (vph)	1198	1209		388			501	
v/c	0.03	0.01		0.09			0.12	
95% queue length	0.09	0.04		0.30			0.40	
Control Delay	8.1	8.0		15.2			13.1	
LOS	A	A		C			B	
Approach Delay				15.2			13.1	
Approach LOS				C			B	

HCS2000: Unsignalized Intersections Release 4.1

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 11/9/01
Analysis Time Period:
Intersection: 2001 EXISTING TRAFFIC VOLUMES
Jurisdiction:
Analysis Year:
Project ID: 512PMEX3
East/West Street: PROSPECT ST.
North/South Street: HIGHLAND AVE.

Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	41	456	12	14	356	14
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR	45	506	13	15	395	15
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	14	4	14	13	7	46
Peak Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR	15	4	15	14	7	51
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Median Storage						
Flared Approach: Exists?		No			No	
Storage						
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	45	15		34			72	
C(m) (vph)	1160	1057		256			390	
v/c	0.04	0.01		0.13			0.18	
95% queue length	0.12	0.04		0.45			0.67	
Control Delay	8.2	8.5		21.2			16.3	
LOS	A	A		C			C	
Approach Delay				21.2			16.3	
Approach LOS				C			C	

HCS2000: Unsignalized Intersections Release 4.1

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 1/28/02
Analysis Time Period:
Intersection: 2001 EXISTING TRAFFIC VOLUMES
Jurisdiction:
Analysis Year:
Project ID: 512AMEX4
East/West Street: WISNER AVE.
North/South Street: COMMONWEALTH AVE.

Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		96	10	10	99	
Peak-Hour Factor, PHF		0.90	0.90	0.90	0.90	
Hourly Flow Rate, HFR		106	11	11	110	
Percent Heavy Vehicles		--	--	0	--	--
Median Type	Undivided					
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	5		15			
Peak Hour Factor, PHF	0.90		0.90			
Hourly Flow Rate, HFR	5		16			
Percent Heavy Vehicles	0		0			
Percent Grade (%)		0			0	
Median Storage						
Flared Approach: Exists?		No				
Storage						
RT Channelized?						
Lanes	0		0			
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		11		21				
C(m) (vph)		1484		889				
v/c		0.01		0.02				
95% queue length		0.02		0.07				
Control Delay		7.4		9.1				
LOS		A		A				
Approach Delay				9.1				
Approach LOS				A				

HCS2000: Unsignalized Intersections Release 4.1

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 1/28/02
Analysis Time Period:
Intersection: 2001 EXISTING TRAFFIC VOLUMES
Jurisdiction:
Analysis Year:
Project ID: 512MDEX4
East/West Street: WISNER AVE.
North/South Street: COMMONWEALTH AVE.

Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		71	5	10	117	
Peak-Hour Factor, PHF		0.90	0.90	0.90	0.90	
Hourly Flow Rate, HFR		78	5	11	130	
Percent Heavy Vehicles		--	--	0	--	--
Median Type	Undivided					
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	5		10			
Peak Hour Factor, PHF	0.90		0.90			
Hourly Flow Rate, HFR	5		11			
Percent Heavy Vehicles	0		0			
Percent Grade (%)		0			0	
Median Storage						
Flared Approach: Exists?		No				
Storage						
RT Channelized?						
Lanes	0		0			
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		11		16				
C(m) (vph)		1527		900				
v/c		0.01		0.02				
95% queue length		0.02		0.05				
Control Delay		7.4		9.1				
LOS		A		A				
Approach Delay				9.1				
Approach LOS				A				

HCS2000: Unsignalized Intersections Release 4.1

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 1/28/02
Analysis Time Period:
Intersection: 2001 EXISTING TRAFFIC VOLUMES
Jurisdiction:
Analysis Year:
Project ID: 512PMEX4
East/West Street: WISNER AVE.
North/South Street: COMMONWEALTH AVE.

Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		64	1	15	127	
Peak-Hour Factor, PHF		0.90	0.90	0.90	0.90	
Hourly Flow Rate, HFR		71	1	16	141	
Percent Heavy Vehicles		--	--	0	--	--
Median Type	Undivided					
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	5		15			
Peak Hour Factor, PHF	0.90		0.90			
Hourly Flow Rate, HFR	5		16			
Percent Heavy Vehicles	0		0			
Percent Grade (%)		0			0	
Median Storage						
Flared Approach: Exists?		No				
Storage						
RT Channelized?						
Lanes	0		0			
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		16		21				
C(m) (vph)		1541		920				
v/c		0.01		0.02				
95% queue length		0.03		0.07				
Control Delay		7.4		9.0				
LOS		A		A				
Approach Delay				9.0				
Approach LOS				A				

HCS2000: Signalized Intersections Release 4.1

Analyst:
Agency:
Date: 12/18/01
Period:
Project ID: 512AMEX5
E/W St: WISNER AVE.

Inter.: 2001 EXISTING TRAFFIC VOLUMES
Area Type: All other areas
Jurisd:
Year :

N/S St: HIGHLAND AVE.

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	1	0	0	1	0	0	1	0	0	1	0
LGConfig		LTR			LTR			LTR			LTR	
Volume	1	82	28	49	84	3	13	211	66	4	344	12
Lane Width		12.0			12.0			16.0			16.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A				NB	Left	A			
	Thru	A					Thru	A			
	Right	A					Right	A			
	Peds						Peds				
WB	Left	A				SB	Left	A			
	Thru	A					Thru	A			
	Right	A					Right	A			
	Peds						Peds				
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		40.0						20.0			
Yellow		3.0						3.0			
All Red		2.0						2.0			

Cycle Length: 70.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
LTR	1022	1789	0.12	0.57	7.0	A	7.0	A
Westbound								
LTR	934	1635	0.16	0.57	7.2	A	7.2	A
Northbound								
LTR	573	2004	0.56	0.29	22.5	C	22.5	C
Southbound								
LTR	612	2142	0.65	0.29	24.4	C	24.4	C

Intersection Delay = 19.0 (sec/veh) Intersection LOS = B

HCS2000: Signalized Intersections Release 4.1

Analyst:
Agency:
Date: 12/18/01
Period:
Project ID: 512MDEX5
E/W St: WISNER AVE.

Inter.: 2001 EXISTING TRAFFIC VOLUMES
Area Type: All other areas
Jurisd:
Year :

N/S St: HIGHLAND AVE.

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	1	0	0	1	0	0	1	0	0	1	0
LGConfig		LTR			LTR			LTR			LTR	
Volume	5	62	14	58	86	6	25	250	60	6	253	16
Lane Width		12.0			12.0			16.0			16.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4	5	6	7	8
EB	Left	A							
	Thru	A							
	Right	A							
	Peds								
WB	Left	A							
	Thru	A							
	Right	A							
	Peds								
NB	Right								
SB	Right								
NB	Left					A			
	Thru					A			
	Right					A			
	Peds								
SB	Left					A			
	Thru					A			
	Right					A			
	Peds								
EB	Right								
WB	Right								
Green		40.0				20.0			
Yellow		3.0				3.0			
All Red		2.0				2.0			

Cycle Length: 70.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
LTR	1017	1780	0.09	0.57	6.8	A	6.8	A
Westbound								
LTR	927	1622	0.18	0.57	7.3	A	7.3	A
Northbound								
LTR	566	1981	0.66	0.29	24.8	C	24.8	C
Southbound								
LTR	604	2115	0.51	0.29	21.6	C	21.6	C

Intersection Delay = 18.9 (sec/veh) Intersection LOS = B

HCS2000: Signalized Intersections Release 4.1

Analyst:
Agency:
Date: 12/18/01
Period:
Project ID: 512PMEX5
E/W St: WISNER AVE.

Inter.: 2001 EXISTING TRAFFIC VOLUMES
Area Type: All other areas
Jurisd:
Year :

N/S St: HIGHLAND AVE.

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	1	0	0	1	0	0	1	0	0	1	0
LGConfig		LTR			LTR			LTR			LTR	
Volume	9	60	26	75	147	11	82	328	47	9	279	34
Lane Width		12.0			12.0			16.0			16.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4	5	6	7	8
EB Left	A				NB Left	A		
Thru	A				Thru	A		
Right	A				Right	A		
Peds					Peds			
WB Left	A				SB Left	A		
Thru	A				Thru	A		
Right	A				Right	A		
Peds					Peds			
NB Right					EB Right			
SB Right					WB Right			
Green	40.0				20.0			
Yellow	3.0				3.0			
All Red	2.0				2.0			

Cycle Length: 70.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
LTR	992	1736	0.11	0.57	6.9	A	6.9	A
Westbound								
LTR	929	1626	0.28	0.57	7.8	A	7.8	A
Northbound								
LTR	443	1549	1.14	0.29	113.6	F	113.6	F
Southbound								
LTR	595	2081	0.60	0.29	23.3	C	23.3	C

Intersection Delay = 55.9 (sec/veh) Intersection LOS = E

HCS2000: Signalized Intersections Release 4.1a

Analyst:
Agency:
Date: 12/18/01
Period:
Project ID: 512AMEX6
E/W St: NYS 17M & NYS 211

Inter.: 2001 EXISTING TRAFFIC VOLUMES
Area Type: All other areas
Jurisd:
Year :

N/S St: HIGHLAND AVE.

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	1	0	0	1	0	0	1	0	1	1	0
LGConfig		LTR			LTR			LTR		L	TR	
Volume	140	352	14	8	238	1	9	87	23	4	321	112
Lane Width		14.0			16.0			16.0		11.0	11.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4	5	6	7	8
EB Left	A				NB Left	A		
Thru	A				Thru	A		
Right	A				Right	A		
Peds					Peds			
WB Left	A				SB Left	A		
Thru	A				Thru	A		
Right	A				Right	A		
Peds					Peds			
NB Right					EB Right			
SB Right					WB Right			
Green	28.0					32.0		
Yellow	3.0					3.0		
All Red	2.0					2.0		

Cycle Length: 70.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
LTR	595	1487	0.95	0.40	44.6	D	44.6	D
Westbound								
LTR	763	1907	0.36	0.40	15.0	B	15.0	B
Northbound								
LTR	867	1897	0.15	0.46	11.2	B	11.2	B
Southbound								
L	561	1228	0.01	0.46	10.4	B		
TR	667	1458	0.72	0.46	19.2	B	19.1	B

Intersection Delay = 27.5 (sec/veh) Intersection LOS = C

HCS2000: Signalized Intersections Release 4.1a

Analyst:
Agency:
Date: 12/18/01
Period:
Project ID: 512MDEX6
E/W St: NYS 17M & NYS 211

Inter.: 2001 EXISTING TRAFFIC VOLUMES
Area Type: All other areas
Jurisd:
Year :

N/S St: HIGHLAND AVE.

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	1	0	0	1	0	0	1	0	1	1	0
LGConfig		LTR			LTR			LTR		L	TR	
Volume	152	238	11	19	353	1	12	203	27	16	196	152
Lane Width		14.0			16.0			16.0		11.0	11.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A				NB	Left	A			
	Thru	A					Thru	A			
	Right	A					Right	A			
	Peds						Peds				
WB	Left	A				SB	Left	A			
	Thru	A					Thru	A			
	Right	A					Right	A			
	Peds						Peds				
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		28.0						32.0			
Yellow		3.0						3.0			
All Red		2.0						2.0			

Cycle Length: 70.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
LTR	468	1171	0.95	0.40	49.8	D	49.8	D
Westbound								
LTR	750	1876	0.55	0.40	17.1	B	17.1	B
Northbound								
LTR	895	1958	0.30	0.46	12.1	B	12.1	B
Southbound								
L	483	1057	0.04	0.46	10.5	B		
TR	664	1452	0.58	0.46	15.4	B	15.2	B

Intersection Delay = 25.2 (sec/veh) Intersection LOS = C

HCS2000: Signalized Intersections Release 4.1a

Analyst:
Agency:
Date: 12/18/01
Period:
Project ID: 512PMEX6
E/W St: NYS 17M & NYS 211

Inter.: 2001 EXISTING TRAFFIC VOLUMES
Area Type: All other areas
Jurisd:
Year :

N/S St: HIGHLAND AVE.

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	1	0	0	1	0	0	1	0	1	1	0
LGConfig		LTR			LTR			LTR		L	TR	
Volume	158	299	18	16	386	5	15	292	27	15	199	165
Lane Width		14.0			16.0			16.0		11.0	11.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A				NB	Left	A			
	Thru	A					Thru	A			
	Right	A					Right	A			
	Peds						Peds				
WB	Left	A				SB	Left	A			
	Thru	A					Thru	A			
	Right	A					Right	A			
	Peds						Peds				
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		28.0						32.0			
Yellow		3.0						3.0			
All Red		2.0						2.0			

Cycle Length: 70.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
LTR	466	1165	1.13	0.40	104.5	F	104.5	F
Westbound								
LTR	748	1870	0.61	0.40	18.0	B	18.0	B
Northbound								
LTR	898	1964	0.41	0.46	13.0	B	13.0	B
Southbound								
L	411	899	0.04	0.46	10.6	B		
TR	664	1452	0.61	0.46	15.9	B	15.7	B

Intersection Delay = 42.2 (sec/veh) Intersection LOS = D

APPENDIX "D"

STANDARDS

LEVEL OF SERVICE FOR SIGNALIZED INTERSECTIONS

Level of Service (LOS) for signalized intersections is defined in terms of control delay, which is a measure of driver discomfort, frustration, fuel consumption, and increased travel time. The delay experienced by a motorist is made up of a number of factors that relate to control, geometrics, traffic, and incidents. Specifically, LOS criteria for traffic signals are stated in terms of the average control delay per vehicle, typically for a 15-minute analysis period. The criteria are given in Exhibit 16-2 from the 2000 Highway Capacity Manual published by the Transportation Research Board.

EXHIBIT 16-2

LEVEL OF SERVICE FOR SIGNALIZED INTERSECTIONS

LEVEL OF SERVICE (LOS)	CONTROL DELAY PER VEHICLE (S/VEH)
A	≤10
B	>10-20
C	>20-35
D	>35-55
E	>55-80
F	>80

LEVEL OF SERVICE A describes operations with low control delay, up to 10 seconds per vehicle (s/veh). This LOS occurs when progression is extremely favorable and most vehicles arrive during the green phase. Many vehicles do not stop at all. Short cycle lengths may tend to contribute to low delay values.

LEVEL OF SERVICE B describes operations with control delay greater than 10 and up to 20 seconds per vehicle (s/veh). This level generally occurs with good progression, short cycle lengths, or both. More vehicles stop than with Level of Service "A", causing higher levels of delay.

LEVEL OF SERVICE C describes operations with control delay greater than 20 and up to 35 seconds per vehicle (s/veh). These higher delays may result from only fair progression, longer cycle lengths, or both. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant at this level, though many still pass through the intersection without stopping.

LEVEL OF SERVICE D describes operations with control delay greater than 35 and up to 55 seconds per vehicle (s/veh). At Level of Service D, the influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, and high v/c ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

LEVEL OF SERVICE E describes operations with control delay greater than 55 and up to 80 seconds per vehicle (s/veh). This is considered to be the limit of acceptable delay. These high delay values generally indicate poor progression, long cycle lengths, and high v/c ratios. Individual cycle failures are frequent.

LEVEL OF SERVICE F describes operations with control delay in excess of 86 seconds per vehicle (s/veh). This level is considered unacceptable to most drivers, often occurs with oversaturation, that is, when arrival flow rates exceed the capacity of the groups. It may also occur at high v/c ratios with many individual cycle failures. Poor progression and long cycle lengths may also contribute significantly to high delay levels.

LEVEL OF SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS

The Level of Service (LOS) for unsignalized intersections is determined by the computed or measured control delay and is defined for each minor movement. Control delay is defined as the total elapsed time a vehicle stops at the end of the queue to the time the vehicle departs from the stop line. This total elapsed time includes the time required for the vehicle to travel from the last-in-queue position to the first-in-queue position, including deceleration of vehicles from free-flow speed to speed of vehicles in queue. Average control delay for any particular minor movement is a function of the capacity of the approach and the degree of saturation. The Level of Service Criteria are given in Exhibit 17-2 from the 2000 Highway Capacity Manual published by the Transportation Research Board.

EXHIBIT 17-2

LEVEL OF SERVICE FOR CRITERIA
FOR UNSIGNALIZED INTERSECTIONS

LEVEL OF SERVICE (LOS)	AVERAGE CONTROL DELAY (S/VEH)
A	0-10
B	>10-15
C	>15-25
D	>25-35
E	>35-50
F	>50

The Level of Service Criteria for unsignalized intersections are somewhat different from the criteria for signalized intersections.

APPENDIX "E"

COPIES OF TRAFFIC VOLUME, VEHICLE SPEED AND CLASSIFICATION DATA

Weather : Machine A (SB)
Counted by:
Board # : VEHICLE SPEEDS
Other :
Street name :HIGHLAND SB BETWEEN - PROSPECT & LINDEN PL. A to B

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 512000000111
Start Date: 10/23/2001
File I.D. : C:\PROGRAM FI
Page : 1

Begin Time	Int. Total	0-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-9999	
12:00 10/23	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
01:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
02:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
03:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
04:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
05:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
06:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
07:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
08:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
09:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
10:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
11:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
12:00 pm	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
01:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
02:00	368	8	20	54	116	114	47	6	0	0	0	0	0	0	3	
03:00	373	0	3	12	93	188	67	9	1	0	0	0	0	0	0	
04:00	348	0	2	10	61	170	92	10	3	0	0	0	0	0	0	
05:00	333	1	0	8	51	184	78	10	0	1	0	0	0	0	0	
06:00	268	2	2	11	87	120	42	3	1	0	0	0	0	0	0	
07:00	183	0	0	5	41	107	28	2	0	0	0	0	0	0	0	
08:00	124	2	0	4	20	61	28	8	1	0	0	0	0	0	0	
09:00	71	0	0	1	10	28	28	3	1	0	0	0	0	0	0	
10:00	73	0	0	1	12	41	13	6	0	0	0	0	0	0	0	
11:00	27	0	0	1	2	10	8	4	1	0	1	0	0	0	0	
Day Totals	2168	13	27	107	493	1023	431	61	8	1	1	*	*	*	3	*
12:00 10/24	14	0	0	0	3	2	7	2	0	0	0	0	0	0	0	
01:00	5	0	0	0	1	3	1	0	0	0	0	0	0	0	0	
02:00	6	0	0	0	1	2	2	1	0	0	0	0	0	0	0	
03:00	9	0	0	0	2	5	2	0	0	0	0	0	0	0	0	
04:00	22	0	0	0	4	12	3	1	2	0	0	0	0	0	0	
05:00	111	1	0	7	32	54	15	1	1	0	0	0	0	0	0	
06:00	288	6	8	15	68	135	52	3	0	0	0	0	0	0	1	
07:00	504	0	2	16	107	243	115	18	3	0	0	0	0	0	0	
08:00	322	1	0	7	69	149	77	17	1	0	0	0	0	0	1	
09:00	254	0	1	7	62	87	76	18	3	0	0	0	0	0	0	
10:00	290	2	4	11	72	123	64	13	1	0	0	0	0	0	0	
11:00	279	0	0	4	38	131	87	18	1	0	0	0	0	0	0	
12:00 pm	269	0	0	7	42	108	90	18	4	0	0	0	0	0	0	
01:00	333	2	8	23	115	122	50	11	1	0	1	0	0	0	0	
02:00	416	0	0	16	96	201	96	7	0	0	0	0	0	0	0	
03:00	386	1	1	10	88	184	92	9	1	0	0	0	0	0	0	
04:00	395	0	0	24	94	205	58	14	0	0	0	0	0	0	0	
05:00	388	2	3	16	109	187	60	9	2	0	0	0	0	0	0	
06:00	285	1	0	10	97	140	35	2	0	0	0	0	0	0	0	
07:00	171	0	1	10	39	82	31	7	1	0	0	0	0	0	0	
08:00	152	0	0	7	42	69	30	2	2	0	0	0	0	0	0	
09:00	82	0	0	2	24	30	23	2	1	0	0	0	0	0	0	
10:00	64	0	0	4	14	24	18	4	0	0	0	0	0	0	0	
11:00	40	0	0	1	5	18	12	2	0	1	0	1	0	0	0	
Day Totals	5085	16	28	197	1224	2316	1096	179	24	1	1	1	*	*	2	*

Weather : Machine A (SB)
Counted by:
Board # : VEHICLE SPEEDS
Other :

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 512000000111
Start Date: 10/23/2001
File I.D. : C:\PROGRAM FI

Street name :HIGHLAND SB BETWEEN Cross street:PROSPECT & LINDEN PL. A to B

Begin Time	Int. Total	0-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-9999
12:00 10/25	13	0	0	0	0	6	4	3	0	0	0	0	0	0	0
01:00	5	0	0	0	1	2	1	0	1	0	0	0	0	0	0
02:00	12	0	0	0	3	3	4	2	0	0	0	0	0	0	0
03:00	7	0	0	0	1	3	3	0	0	0	0	0	0	0	0
04:00	32	0	1	0	6	17	8	0	0	0	0	0	0	0	0
05:00	101	0	0	6	26	45	21	2	1	0	0	0	0	0	0
06:00	289	6	6	11	86	109	66	5	0	0	0	0	0	0	0
07:00	466	0	1	3	89	229	127	15	2	0	0	0	0	0	0
08:00	355	2	0	9	79	160	90	10	3	2	0	0	0	0	0
09:00	237	0	0	10	45	112	55	11	4	0	0	0	0	0	0
10:00	300	1	2	21	63	148	56	9	0	0	0	0	0	0	0
11:00	300	0	0	5	58	141	75	19	2	0	0	0	0	0	0
12:00 pm	259	0	1	5	47	99	82	21	3	1	0	0	0	0	0
01:00	325	5	1	15	102	134	60	7	1	0	0	0	0	0	0
02:00	419	0	2	9	82	213	92	21	0	0	0	0	0	0	0
03:00	332	1	0	2	48	153	93	30	5	0	0	0	0	0	0
04:00	343	2	1	14	65	166	83	11	1	0	0	0	0	0	0
05:00	367	0	7	11	101	161	76	8	2	1	0	0	0	0	0
06:00	273	1	1	8	66	137	51	7	2	0	0	0	0	0	0
07:00	183	1	0	10	55	78	34	4	1	0	0	0	0	0	0
08:00	114	1	0	4	26	52	27	4	0	0	0	0	0	0	0
09:00	88	1	1	1	18	42	19	4	2	0	0	0	0	0	0
10:00	66	0	0	4	10	30	12	9	1	0	0	0	0	0	0
11:00	36	0	0	1	4	17	6	8	0	0	0	0	0	0	0
Day Totals	4922	21	24	149	1081	2257	1145	210	31	4	*	*	*	*	*
12:00 10/26	16	0	0	0	0	9	4	3	0	0	0	0	0	0	0
01:00	12	0	0	0	3	7	1	1	0	0	0	0	0	0	0
02:00	17	0	0	0	2	5	5	4	1	0	0	0	0	0	0
03:00	13	0	0	0	2	3	6	2	0	0	0	0	0	0	0
04:00	34	0	0	2	8	14	7	1	2	0	0	0	0	0	0
05:00	97	0	0	3	24	49	19	2	0	0	0	0	0	0	0
06:00	277	2	7	33	79	119	33	2	0	0	0	0	0	0	2
07:00	460	2	1	7	92	234	103	18	3	0	0	0	0	0	0
08:00	336	1	0	7	75	180	63	9	1	0	0	0	0	0	0
09:00	279	0	2	10	45	135	73	12	2	0	0	0	0	0	0
10:00	319	1	2	10	95	153	47	10	0	1	0	0	0	0	0
11:00	2	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Grand Total	14037	56	91	525	3224	6504	3034	514	72	7	2	1	0	0	7

Speed Statistics.

15th Percentile Speed :	27 MPH
Median Speed (50th percentile):	32 MPH
Average Speed - All Vehicles :	33 MPH
85th Percentile Speed :	37 MPH
95th Percentile Speed :	39 MPH
10 MPH Pace Speed :	26-35 MPH
Number of Vehicles in Pace :	9728
Percent of Vehicles in Pace :	69.32%
Number of Vehicles > 55 MPH :	10
Percent of Vehicles > 55 MPH:	.07%

Weather : Machine A (SB)
Counted by:
Board # :
Other :
VOLUME DATA

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 512000000111
Start Date: 10/23/2001
File I.D. : C:\PROGRAM FI
Page : 1

Street name :HIGHLAND BETWEEN Cross street:PROSPECT ST. & LINDEN PL. A to B

Begin Time	Tues. 10/23 Ch. 1	2	Wed. 10/24 Ch. 1	2
12:00	*	*	14	0
01:00	*	*	5	0
02:00	*	*	6	0
03:00	*	*	9	0
04:00	*	*	22	0
05:00	*	*	111	0
06:00	*	*	288	1
07:00	*	*	504	0
08:00	*	*	322	2
09:00	*	*	254	0
10:00	*	*	290	0
11:00	*	*	279	0
12:00	*	*	269	1
01:00	*	*	333	0
02:00	368	8	416	0
03:00	373	0	386	0
04:00	348	0	395	0
05:00	333	0	388	0
06:00	268	0	285	0
07:00	183	1	171	0
08:00	124	0	152	0
09:00	71	0	82	0
10:00	73	0	64	0
11:00	27	0	40	0
Totals	2168	9	5085	4
Day Totals	2177		5089	

AM Peaks			07:00	08:00
Volume			504	2
PM Peaks	03:00	02:00	02:00	12:00
Volume	373	8	416	1

Weather : Machine A (SB)
Counted by:
Board # : VOLUME DATA
Other :

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 512000000111
Start Date: 10/23/2001
File I.D. : C:\PROGRAM FI
Page : 2

Street name :HIGHLAND BETWEEN Cross street:PROSPECT ST. & LINDEN PL. A to B

Begin Time	Thur. 10/25 Ch. 1	2	Fri. 10/26 Ch. 1	2
12:00	13	0	16	0
01:00	5	0	12	0
02:00	12	0	17	0
03:00	7	0	13	0
04:00	32	0	34	0
05:00	101	0	97	0
06:00	289	0	277	3
07:00	466	0	460	0
08:00	355	0	336	1
09:00	237	0	279	0
10:00	300	0	319	1
11:00	300	0	2	0
12:00	259	2	*	*
01:00	325	0	*	*
02:00	419	0	*	*
03:00	332	0	*	*
04:00	343	0	*	*
05:00	367	1	*	*
06:00	273	0	*	*
07:00	183	0	*	*
08:00	114	0	*	*
09:00	88	0	*	*
10:00	66	0	*	*
11:00	36	0	*	*
Totals	4922	3	1862	5
Day Totals	4925		1867	

AM Peaks	07:00		07:00	06:00
Volume	466		460	3
PM Peaks	02:00	12:00		
Volume	419	2		

Weather : Machine A (SB)
Counted by:
Board # : VEHICLE CLASSIFICATION
Other :

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 512000000111
Start Date: 10/23/2001
File I.D. : 512L1C
Page : 1

Street name :HIGHLAND BETWEEN Cross street:PROSPECT ST & LINDEN PL A to B

Begin Time	Int. Total	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11	Class 12	Class 13	Class 14	
12:00 10/23	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
01:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
02:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
03:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
04:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
05:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
06:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
07:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
08:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
09:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
10:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
11:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
12:00 pm	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
01:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
02:00	368	0	301	52	3	5	0	0	2	0	0	0	0	0	5	
03:00	373	0	316	48	0	7	0	0	0	0	0	0	0	0	2	
04:00	348	1	297	40	0	5	0	0	1	0	0	0	0	0	4	
05:00	333	0	290	38	0	1	0	0	3	0	0	0	0	0	1	
06:00	268	1	232	32	0	1	0	0	0	0	0	0	0	0	2	
07:00	183	0	162	18	0	3	0	0	0	0	0	0	0	0	0	
08:00	124	0	117	6	0	0	0	0	0	0	0	0	0	0	1	
09:00	71	0	60	11	0	0	0	0	0	0	0	0	0	0	0	
10:00	73	0	70	3	0	0	0	0	0	0	0	0	0	0	0	
11:00	27	0	27	0	0	0	0	0	0	0	0	0	0	0	0	
Day Totals	2168	2	1872	248	3	22	*	*	6	*	*	*	*	*	15	*
12:00 10/24	14	0	12	1	0	0	0	0	0	0	0	0	0	0	1	
01:00	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	
02:00	6	0	3	2	0	1	0	0	0	0	0	0	0	0	0	
03:00	9	0	8	0	0	1	0	0	0	0	0	0	0	0	0	
04:00	22	0	16	5	0	1	0	0	0	0	0	0	0	0	0	
05:00	111	0	86	22	1	0	0	0	0	0	1	0	0	0	1	
06:00	288	0	225	50	4	4	0	0	1	0	0	0	0	0	4	
07:00	504	0	409	68	3	13	1	0	3	0	0	0	0	0	7	
08:00	322	0	268	36	0	9	1	0	2	0	0	0	0	0	6	
09:00	254	0	205	41	1	5	0	0	1	0	1	0	0	0	0	
10:00	290	0	236	35	2	9	0	0	4	0	0	0	0	0	4	
11:00	279	0	235	41	0	3	0	0	0	0	0	0	0	0	0	
12:00 pm	269	0	207	47	1	10	0	0	1	0	0	0	0	0	3	
01:00	333	1	251	51	8	16	0	0	3	0	0	0	0	0	3	
02:00	416	1	333	65	2	12	1	0	0	0	0	0	0	0	2	
03:00	386	2	308	65	1	7	0	1	1	0	0	0	0	0	1	
04:00	395	4	324	62	0	3	0	0	0	0	0	0	0	0	2	
05:00	388	3	330	44	0	4	0	0	1	0	0	0	0	0	6	
06:00	285	1	242	35	0	3	0	0	1	0	0	0	0	0	3	
07:00	171	0	155	11	0	5	0	0	0	0	0	0	0	0	0	
08:00	152	1	133	17	0	1	0	0	0	0	0	0	0	0	0	
09:00	82	0	70	10	0	2	0	0	0	0	0	0	0	0	0	
10:00	64	0	61	3	0	0	0	0	0	0	0	0	0	0	0	
11:00	40	1	36	2	0	0	0	0	0	0	0	0	0	0	1	
Day Totals	5085	14	4158	713	23	109	3	1	18	*	2	*	*	*	44	*

Weather : Machine A (SB)
Counted by:
Board # : VEHICLE CLASSIFICATION
Other :

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 512000000111
Start Date: 10/23/2001
File I.D. : 512L1C
Page : 2

Street name :HIGHLAND BETWEEN Cross street:PROSPECT ST & LINDEN PL A to B

Begin Time	Int. Total	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11	Class 12	Class 13	Class 14
12:00 10/25	13	0	12	1	0	0	0	0	0	0	0	0	0	0	0
01:00	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0
02:00	12	0	10	2	0	0	0	0	0	0	0	0	0	0	0
03:00	7	0	4	2	0	1	0	0	0	0	0	0	0	0	0
04:00	32	0	23	8	1	0	0	0	0	0	0	0	0	0	0
05:00	101	0	82	17	1	1	0	0	0	0	0	0	0	0	0
06:00	289	0	218	59	3	6	0	0	1	0	0	0	0	0	2
07:00	466	1	371	73	4	13	0	0	2	0	0	0	0	0	2
08:00	355	0	285	48	2	12	0	0	2	1	1	0	0	0	4
09:00	237	1	195	34	2	4	1	0	0	0	0	0	0	0	0
10:00	300	1	231	55	1	7	1	0	2	0	0	0	1	0	1
11:00	300	0	239	51	2	5	0	0	0	0	0	0	0	0	3
12:00 pm	259	1	204	45	0	8	0	0	1	0	0	0	0	0	0
01:00	325	0	241	63	9	11	0	0	0	0	0	0	0	0	1
02:00	419	2	347	50	3	14	0	0	1	0	0	0	0	0	2
03:00	332	0	290	34	0	4	1	0	1	0	0	0	0	0	2
04:00	343	1	285	47	0	3	0	0	2	0	0	0	0	0	5
05:00	367	2	317	38	0	6	0	0	0	0	0	0	0	0	4
06:00	273	0	240	28	0	2	0	0	0	0	0	0	0	0	3
07:00	183	0	159	21	0	0	0	0	1	0	0	0	0	0	2
08:00	114	0	100	11	0	0	0	0	1	0	0	0	0	0	2
09:00	88	0	81	7	0	0	0	0	0	0	0	0	0	0	0
10:00	66	0	60	6	0	0	0	0	0	0	0	0	0	0	0
11:00	36	0	35	1	0	0	0	0	0	0	0	0	0	0	0
Day Totals	4922	9	4034	701	28	97	3	*	14	1	1	*	1	*	33
12:00 10/26	16	0	13	3	0	0	0	0	0	0	0	0	0	0	0
01:00	12	0	11	1	0	0	0	0	0	0	0	0	0	0	0
02:00	17	0	14	2	0	0	0	0	0	0	0	0	0	0	1
03:00	13	0	10	3	0	0	0	0	0	0	0	0	0	0	0
04:00	34	0	26	7	0	1	0	0	0	0	0	0	0	0	0
05:00	97	0	74	20	1	2	0	0	0	0	0	0	0	0	0
06:00	277	0	209	44	4	7	0	0	3	0	0	0	0	0	10
07:00	460	0	371	69	2	9	0	0	2	0	0	0	0	0	7
08:00	336	1	268	49	2	12	0	0	0	0	1	0	0	0	3
09:00	279	0	224	40	1	10	0	0	2	0	0	0	0	0	2
10:00	319	1	259	45	3	6	0	0	3	0	0	0	0	0	2
11:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Totals	14037	27	11545	1945	67	275	6	1	48	1	4	0	1	0	117
Percent		.1%	82.2%	13.8%	.4%	1.9%	.0%	.0%	.3%	.0%	.0%	.0%	.0%	.0%	.8%

Weather : Machine C (SB)
Counted by:
Board # :
Other : VOLUME DATA

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 000000512002
Start Date: 10/22/2001
File I.D. : 512L2V
Page : 1

Street name :HIGHLAND BETWEEN Cross street:SUNSET ST. & JAY ST. A to B

Begin Time	10/22 Int.	Mon. Total	10/23 Int.	Tues. Total	10/24 Int.	Wed. Total	10/25 Int.	Thur. Total	10/26 Int.	Fri. Total	Weekday Avg.	10/27	Sat. Total	10/28 Int.	Sun. Total
12:00 am		*		*		45		45		43	44		*		*
01:00		*		*		16		15		18	16		*		*
02:00		*		*		6		8		9	8		*		*
03:00		*		*		5		9		13	9		*		*
04:00		*		*		7		5		17	10		*		*
05:00		*		*		14		18		20	17		*		*
06:00		*		*		52		51		52	52		*		*
07:00		*		*		204		203		196	201		*		*
08:00		*		*		428		429		390	416		*		*
09:00		*		*		381		379		366	375		*		*
10:00		*		*		253		239		248	247		*		*
11:00		*		*		248		235		185	223		*		*
12:00 pm		*		*		246		273		*	260		*		*
01:00		*		*		266		240		*	253		*		*
02:00		*		*		294		273		*	284		*		*
03:00		*		*		351		342		*	346		*		*
04:00		*		*		363		337		*	350		*		*
05:00		*		326		378		337		*	347		*		*
06:00		*		303		328		337		*	323		*		*
07:00		*		302		329		275		*	302		*		*
08:00		*		155		204		192		*	184		*		*
09:00		*		131		118		133		*	127		*		*
10:00		*		70		84		81		*	78		*		*
11:00		*		52		51		56		*	53		*		*
Totals		0		1339		4671		4512		1557	4525		0		0
Avg. WkDay		.0%		29.5%		103.2%		99.7%		34.4%			.0%		.0%
AM Peaks						08:00		08:00		08:00	08:00				
Volume						428		429		390	416				
PM Peaks				05:00		05:00		03:00			04:00				
Volume				326		378		342			350				

ADTs

Weather : Machine C (SB)
Counted by:
Board # : VOLUME DATA
Other :

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 000000512002
Start Date: 10/23/2001
File I.D. : C:\PROGRAM FI
Page : 1

Street name :HIGHLAND BETWEEN Cross street:SUNSET ST. & JAY ST. A to B

Begin Time	Tues. 10/23	Ch. 1	2	Wed. 10/24	Ch. 1	2
12:00		*	*		45	0
01:00		*	*		16	0
02:00		*	*		6	0
03:00		*	*		5	0
04:00		*	*		7	0
05:00		*	*		12	2
06:00		*	*		52	0
07:00		*	*		202	2
08:00		*	*		428	0
09:00		*	*		381	0
10:00		*	*		253	0
11:00		*	*		248	0
12:00		*	*		246	0
01:00		*	*		264	2
02:00		*	*		293	1
03:00		*	*		350	1
04:00		*	*		363	0
05:00		318	8		378	0
06:00		303	0		328	0
07:00		302	0		328	1
08:00		155	0		204	0
09:00		131	0		19	99
10:00		70	0		0	84
11:00		52	0		9	42
Totals		1331	8		4437	234
Day Totals		1339			4671	

AM Peaks			08:00	05:00
Volume			428	2
PM Peaks	05:00	05:00	05:00	09:00
Volume	318	8	378	99

Weather : Machine C (SB)
Counted by:
Board # : VOLUME DATA
Other :

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 000000512002
Start Date: 10/23/2001
File I.D. : C:\PROGRAM FI
Page : 2

Street name :HIGHLAND BETWEEN Cross street:SUNSET ST. & JAY ST. A to B

Begin Time	Thur. 10/25 Ch. 1	2	Fri. 10/26 Ch. 1	2
12:00	45	0	43	0
01:00	15	0	18	0
02:00	8	0	9	0
03:00	9	0	13	0
04:00	5	0	17	0
05:00	17	1	19	1
06:00	51	0	52	0
07:00	201	2	196	0
08:00	428	1	382	8
09:00	379	0	366	0
10:00	239	0	248	0
11:00	235	0	181	4
12:00	273	0	*	*
01:00	240	0	*	*
02:00	273	0	*	*
03:00	342	0	*	*
04:00	337	0	*	*
05:00	337	0	*	*
06:00	336	1	*	*
07:00	275	0	*	*
08:00	192	0	*	*
09:00	133	0	*	*
10:00	81	0	*	*
11:00	56	0	*	*
Totals	4507	5	1544	13
Day Totals	4512		1557	

AM Peaks	08:00	07:00	08:00	08:00
Volume	428	2	382	8
PM Peaks	03:00	06:00		
Volume	342	1		

Weather : Machine C (SB)
Counted by:
Board # : VEHICLE SPEEDS
Other :

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 000000512002
Start Date: 10/23/2001
File I.D. : C:\PROGRAM FI

Street name :HIGHLAND SB BETWEEN Cross street:SUNSET & JAY A to B

Begin Time	Int. Total	0-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-9999	
12:00 10/23	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
01:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
02:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
03:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
04:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
05:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
06:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
07:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
08:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
09:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
10:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
11:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
12:00 pm	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
01:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
02:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
03:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
04:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
05:00	318	2	5	6	24	128	100	43	5	1	0	0	0	0	4	
06:00	303	0	3	3	11	112	116	48	10	0	0	0	0	0	0	
07:00	302	0	2	6	41	129	95	26	3	0	0	0	0	0	0	
08:00	155	0	1	0	15	79	46	14	0	0	0	0	0	0	0	
09:00	131	0	0	2	14	52	48	13	2	0	0	0	0	0	0	
10:00	70	0	0	1	5	26	30	5	3	0	0	0	0	0	0	
11:00	52	0	0	0	5	19	20	6	2	0	0	0	0	0	0	
Day Totals	1331	2	11	18	115	545	455	155	25	1	*	*	*	*	4	*
12:00 10/24	45	0	0	1	2	18	17	5	1	0	1	0	0	0	0	
01:00	16	0	0	0	1	4	5	4	2	0	0	0	0	0	0	
02:00	6	0	0	1	0	3	2	0	0	0	0	0	0	0	0	
03:00	5	0	0	0	0	2	2	0	1	0	0	0	0	0	0	
04:00	7	0	0	0	0	5	2	0	0	0	0	0	0	0	0	
05:00	12	0	0	0	1	5	4	0	2	0	0	0	0	0	0	
06:00	52	0	0	0	9	17	20	5	0	0	1	0	0	0	0	
07:00	202	5	4	11	37	93	44	7	0	0	0	0	0	0	1	
08:00	428	1	2	2	33	186	159	38	7	0	0	0	0	0	0	
09:00	381	1	0	2	27	158	150	36	6	1	0	0	0	0	0	
10:00	253	0	0	1	21	72	108	43	8	0	0	0	0	0	0	
11:00	248	1	0	1	21	98	93	30	4	0	0	0	0	0	0	
12:00 pm	246	1	1	3	13	85	111	24	6	2	0	0	0	0	0	
01:00	264	2	0	2	27	103	96	29	4	1	0	0	0	0	0	
02:00	293	5	6	14	52	106	78	29	3	0	0	0	0	0	0	
03:00	350	2	1	16	48	150	109	22	1	0	1	0	0	0	0	
04:00	363	1	1	6	39	147	138	27	2	2	0	0	0	0	0	
05:00	378	1	5	5	49	140	130	43	4	1	0	0	0	0	0	
06:00	328	0	1	7	38	158	99	20	4	1	0	0	0	0	0	
07:00	328	1	0	9	71	164	63	18	2	0	0	0	0	0	0	
08:00	204	1	0	3	25	98	56	19	2	0	0	0	0	0	0	
09:00	19	0	0	0	1	8	7	3	0	0	0	0	0	0	0	
10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11:00	9	0	0	0	0	4	3	2	0	0	0	0	0	0	0	
Day Totals	4437	22	21	84	515	1824	1496	404	59	8	3	*	*	*	1	*

Weather : Machine C (SB)
Counted by:
Board # :
Other : VEHICLE SPEEDS

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 000000512002
Start Date: 10/23/2001
File I.D. : C:\PROGRAM FI
Page : 2

Street name :HIGHLAND SB BETWEEN Cross street:SUNSET & JAY A to B

Begin Time	Int. Total	0-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-9999
12:00 10/25	45	0	0	0	3	18	15	7	0	0	0	1	0	0	1
01:00	15	0	0	0	0	5	4	4	1	1	0	0	0	0	0
02:00	8	0	0	0	0	4	2	1	1	0	0	0	0	0	0
03:00	9	0	0	0	0	1	5	2	1	0	0	0	0	0	0
04:00	5	0	0	0	0	1	2	1	1	0	0	0	0	0	0
05:00	17	0	0	0	2	7	6	1	1	0	0	0	0	0	0
06:00	51	1	0	0	4	23	13	9	1	0	0	0	0	0	0
07:00	201	3	3	13	48	81	43	10	0	0	0	0	0	0	0
08:00	428	4	6	8	29	214	144	21	2	0	0	0	0	0	0
09:00	379	0	0	4	47	157	143	23	5	0	0	0	0	0	0
10:00	239	0	1	6	28	100	75	23	5	1	0	0	0	0	0
11:00	235	0	0	0	15	98	96	20	6	0	0	0	0	0	0
12:00 pm	273	1	1	2	27	104	97	35	5	1	0	0	0	0	0
01:00	240	0	0	2	25	70	107	26	8	2	0	0	0	0	0
02:00	273	1	2	3	28	116	94	26	3	0	0	0	0	0	0
03:00	342	0	0	3	39	143	114	37	6	0	0	0	0	0	0
04:00	337	0	0	2	22	111	141	50	10	0	1	0	0	0	0
05:00	337	0	0	6	28	112	148	37	6	0	0	0	0	0	0
06:00	336	0	0	1	36	152	113	33	1	0	0	0	0	0	0
07:00	275	1	1	1	33	132	89	16	2	0	0	0	0	0	0
08:00	192	0	0	2	30	82	59	19	0	0	0	0	0	0	0
09:00	133	0	0	2	21	46	49	11	4	0	0	0	0	0	0
10:00	81	0	0	1	10	35	20	13	2	0	0	0	0	0	0
11:00	56	0	1	0	8	18	16	10	3	0	0	0	0	0	0
Day Totals	4507	11	15	56	483	1830	1595	435	74	5	1	1	*	*	1
12:00 10/26	43	0	0	0	5	15	8	6	9	0	0	0	0	0	0
01:00	18	0	0	0	0	9	8	1	0	0	0	0	0	0	0
02:00	9	0	0	1	0	5	1	1	1	0	0	0	0	0	0
03:00	13	1	0	0	0	5	1	4	0	2	0	0	0	0	0
04:00	17	0	1	0	1	5	5	5	0	0	0	0	0	0	0
05:00	19	0	0	0	3	7	3	4	2	0	0	0	0	0	0
06:00	52	0	0	1	8	23	17	3	0	0	0	0	0	0	0
07:00	196	3	4	19	35	98	32	5	0	0	0	0	0	0	0
08:00	382	12	24	10	39	186	89	19	3	0	0	0	0	0	0
09:00	366	0	0	2	49	184	109	18	4	0	0	0	0	0	0
10:00	248	2	0	0	24	87	90	38	6	1	0	0	0	0	0
11:00	181	2	0	4	15	65	62	23	4	1	0	0	0	0	5
Grand Total	11819	55	76	195	1292	4888	3971	1121	187	18	4	1	0	0	11

Speed Statistics.

15th Percentile Speed :	30 MPH
Median Speed (50th percentile):	34 MPH
Average Speed - All Vehicles :	35 MPH
85th Percentile Speed :	39 MPH
95th Percentile Speed :	43 MPH
10 MPH Pace Speed :	31-40 MPH
Number of Vehicles in Pace :	8859
Percent of Vehicles in Pace :	74.98%
Number of Vehicles > 55 MPH :	16
Percent of Vehicles > 55 MPH:	.14%

Weather : Machine C (SB)
Counted by:
Board # : VEHICLE CLASSIFICATION
Other :

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 000000512002
Start Date: 10/23/2001
File I.D. : C:\PROGRAM FI
Page : 2

Street name :HIGHLAND BETWEEN Cross street:SUNSET ST & JAY ST. A to B

Begin Time	Int. Total	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11	Class 12	Class 13	Class 14
12:00 10/25	45	1	41	3	0	0	0	0	0	0	0	0	0	0	0
01:00	15	0	15	0	0	0	0	0	0	0	0	0	0	0	0
02:00	8	0	8	0	0	0	0	0	0	0	0	0	0	0	0
03:00	9	0	8	1	0	0	0	0	0	0	0	0	0	0	0
04:00	5	0	3	1	0	1	0	0	0	0	0	0	0	0	0
05:00	17	0	12	4	1	0	0	0	0	0	0	0	0	0	0
06:00	51	0	41	9	0	1	0	0	0	0	0	0	0	0	1
07:00	201	1	134	54	4	7	0	0	0	0	0	0	0	0	1
08:00	428	1	337	73	3	10	0	0	3	0	0	0	0	0	8
09:00	379	0	300	56	1	10	0	0	4	0	0	0	0	0	0
10:00	239	0	185	43	2	9	0	0	0	0	0	0	0	0	0
11:00	235	1	180	47	1	4	0	0	2	0	0	0	0	0	0
12:00 pm	273	1	210	51	2	5	0	0	1	0	0	0	0	0	3
01:00	240	0	188	42	0	8	0	0	1	0	0	0	0	0	1
02:00	273	1	201	57	6	8	0	0	0	0	0	0	0	0	0
03:00	342	1	274	48	5	11	0	0	2	1	0	0	0	0	0
04:00	337	0	286	42	1	6	0	0	1	0	0	0	0	0	1
05:00	337	1	278	51	0	3	1	0	1	0	0	0	0	0	2
06:00	336	0	282	49	0	5	0	0	0	0	0	0	0	0	0
07:00	275	0	234	37	0	2	0	0	1	0	0	0	0	0	1
08:00	192	0	162	29	0	0	0	0	1	0	0	0	0	0	0
09:00	133	0	114	18	0	0	0	0	0	0	0	0	0	0	1
10:00	81	0	73	8	0	0	0	0	0	0	0	0	0	0	0
11:00	56	0	50	5	0	0	0	0	0	0	0	0	0	0	1
Day Totals	4507	8	3616	728	26	90	1	*	17	1	*	*	*	*	20 *
12:00 10/26	43	0	41	2	0	0	0	0	0	0	0	0	0	0	0
01:00	18	0	17	1	0	0	0	0	0	0	0	0	0	0	0
02:00	9	0	8	1	0	0	0	0	0	0	0	0	0	0	0
03:00	13	0	10	1	0	0	1	0	0	0	0	0	0	0	1
04:00	17	0	13	3	0	0	1	0	0	0	0	0	0	0	0
05:00	19	0	14	4	0	1	0	0	0	0	0	0	0	0	0
06:00	52	0	39	11	1	1	0	0	0	0	0	0	0	0	0
07:00	196	0	139	47	4	5	0	0	1	0	0	0	0	0	0
08:00	382	0	299	62	4	9	0	0	1	1	1	0	1	0	4
09:00	366	1	286	65	0	10	0	0	1	1	0	0	0	0	2
10:00	248	0	184	49	2	8	0	0	1	0	1	0	0	0	3
11:00	181	0	143	26	0	5	0	0	0	0	0	0	0	0	7
Totals	11819	21	9493	1886	59	231	6	0	45	3	3	0	1	0	71
Percent		.1%	80.3%	15.9%	.5%	1.9%	.0%	.0%	.3%	.0%	.0%	.0%	.0%	.0%	.6%

Weather : Machine C (SB)
Counted by:
Board # :
Other : VEHICLE CLASSIFICATION

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 000000512002
Start Date: 10/23/2001
File I.D. : C:\PROGRAM FI
Page : 1

Street name :HIGHLAND BETWEEN Cross street:SUNSET ST & JAY ST. A to B

Begin Time	Int. Total	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11	Class 12	Class 13	Class 14	
12:00 10/23	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
01:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
02:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
03:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
04:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
05:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
06:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
07:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
08:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
09:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
10:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
11:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
12:00 pm	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
01:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
02:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
03:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
04:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
05:00	318	0	260	45	1	3	0	0	2	0	0	0	0	0	7	
06:00	303	0	255	44	0	1	0	0	2	0	0	0	0	0	1	
07:00	302	0	254	45	0	1	0	0	2	0	0	0	0	0	0	
08:00	155	0	132	20	0	2	1	0	0	0	0	0	0	0	0	
09:00	131	0	121	9	0	0	0	0	0	0	0	0	0	0	1	
10:00	70	0	59	11	0	0	0	0	0	0	0	0	0	0	0	
11:00	52	0	46	6	0	0	0	0	0	0	0	0	0	0	0	
Day Totals	1331	*	1127	180	1	7	1	*	6	*	*	*	*	*	9	*
12:00 10/24	45	0	42	3	0	0	0	0	0	0	0	0	0	0	0	
01:00	16	0	14	1	0	0	0	0	0	0	0	0	0	0	1	
02:00	6	0	6	0	0	0	0	0	0	0	0	0	0	0	0	
03:00	5	0	3	1	0	1	0	0	0	0	0	0	0	0	0	
04:00	7	0	6	1	0	0	0	0	0	0	0	0	0	0	0	
05:00	12	0	10	1	0	1	0	0	0	0	0	0	0	0	0	
06:00	52	0	41	10	0	1	0	0	0	0	0	0	0	0	0	
07:00	202	0	141	47	5	4	0	0	2	0	0	0	0	0	3	
08:00	428	0	345	65	4	8	1	0	1	0	0	0	0	0	4	
09:00	381	0	311	54	0	11	1	0	3	0	0	0	0	0	1	
10:00	253	0	207	41	0	4	0	0	0	0	0	0	0	0	1	
11:00	248	0	200	38	1	7	0	0	2	0	0	0	0	0	0	
12:00 pm	246	0	195	45	0	4	0	0	0	0	0	0	0	0	2	
01:00	264	0	202	49	1	8	0	0	3	0	0	0	0	0	1	
02:00	293	0	228	44	5	12	0	0	2	0	0	0	0	0	2	
03:00	350	2	278	51	4	11	0	0	1	0	0	0	0	0	3	
04:00	363	2	269	78	1	8	0	0	1	0	1	0	0	0	3	
05:00	378	4	309	57	0	4	0	0	3	0	0	0	0	0	1	
06:00	328	2	269	51	0	4	0	0	0	0	0	0	0	0	2	
07:00	328	2	272	50	0	3	0	0	0	0	0	0	0	0	1	
08:00	204	0	184	16	0	4	0	0	0	0	0	0	0	0	0	
09:00	19	0	17	2	0	0	0	0	0	0	0	0	0	0	0	
10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11:00	9	0	8	1	0	0	0	0	0	0	0	0	0	0	0	
Day Totals	4437	12	3557	706	21	95	2	*	18	*	1	*	*	*	25	*

Weather : Machine D (NB)
Counted by:
Board # : VOLUME DATA
Other :

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 000000051205
Start Date: 10/23/2001
File I.D. : 512L5
Page : 1

Street name :HIGHLAND NB BETWEEN Cross street:SUNSET ST & JAY ST A to B

Begin Time	Tues. 10/23 Ch. 1	2	Wed. 10/24 Ch. 1	2
12:00	*	*	16	0
01:00	*	*	9	0
02:00	*	*	6	0
03:00	*	*	12	0
04:00	*	*	32	0
05:00	*	*	113	0
06:00	*	*	204	0
07:00	*	*	235	0
08:00	*	*	193	0
09:00	*	*	187	0
10:00	*	*	276	0
11:00	*	*	278	0
12:00	*	*	247	0
01:00	*	*	315	0
02:00	*	*	387	0
03:00	351	18	399	2
04:00	395	0	394	0
05:00	263	0	277	0
06:00	215	0	209	0
07:00	170	0	199	0
08:00	155	1	175	0
09:00	68	0	78	0
10:00	57	0	48	0
11:00	26	0	44	0
Totals	1700	19	4333	2
Day Totals	1719		4335	

AM Peaks			11:00	
Volume			278	
PM Peaks	04:00	03:00	03:00	03:00
Volume	395	18	399	2

Weather : Machine D (NB)
Counted by:
Board # :
Other :

VOLUME DATA

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 000000051205
Start Date: 10/23/2001
File I.D. : 512L5
Page : 2

Street name :HIGHLAND NB BETWEEN Cross street:SUNSET ST & JAY ST A to B

Begin Time	Thur. 10/25	Ch. 1	2	Fri. 10/26	Ch. 1	2
12:00		10	0		11	0
01:00		3	0		12	0
02:00		5	0		8	0
03:00		13	0		15	0
04:00		29	0		29	0
05:00		117	0		115	0
06:00		197	0		163	1
07:00		251	0		238	0
08:00		230	0		196	1
09:00		207	0		192	0
10:00		268	0		54	7
11:00		219	0		*	*
12:00		246	0		*	*
01:00		290	0		*	*
02:00		381	0		*	*
03:00		352	0		*	*
04:00		398	0		*	*
05:00		276	0		*	*
06:00		195	0		*	*
07:00		155	0		*	*
08:00		149	0		*	*
09:00		81	0		*	*
10:00		45	0		*	*
11:00		24	0		*	*
Totals		4141	0		1033	9
Day Totals		4141			1042	

AM Peaks	10:00		07:00	10:00
Volume	268		238	7
PM Peaks	04:00			
Volume	398			

Weather : Machine D (NB)
Counted by:
Board # :
Other : VEHICLE SPEEDS

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 000000051205
Start Date: 10/23/2001
File I.D. : C:\PROGRAM FI
Page : 1

Street name :HIGHLAND NB BETWEEN Cross street:SUNSET & JAY ST. A to B

Begin Time	Int. Total	0-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-9999	
12:00 10/23	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
01:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
02:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
03:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
04:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
05:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
06:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
07:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
08:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
09:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
10:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
11:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
12:00 pm	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
01:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
02:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
03:00	351	5	11	31	72	131	82	13	3	0	0	0	0	0	3	
04:00	395	1	0	4	51	175	111	40	11	2	0	0	0	0	0	
05:00	263	0	3	8	39	112	78	20	2	1	0	0	0	0	0	
06:00	215	0	1	5	33	101	66	9	0	0	0	0	0	0	0	
07:00	170	0	0	4	30	64	62	9	1	0	0	0	0	0	0	
08:00	155	0	0	1	17	86	40	9	2	0	0	0	0	0	0	
09:00	68	0	0	2	4	39	12	9	2	0	0	0	0	0	0	
10:00	57	0	0	0	12	22	12	9	2	0	0	0	0	0	0	
11:00	26	0	0	1	1	11	8	2	2	1	0	0	0	0	0	
Day Totals	1700	6	15	56	259	741	471	120	25	4	*	*	*	*	3	*
12:00 10/24	16	0	0	0	0	5	8	1	1	1	0	0	0	0	0	
01:00	9	0	0	0	5	1	3	0	0	0	0	0	0	0	0	
02:00	6	0	0	0	2	1	1	1	1	0	0	0	0	0	0	
03:00	12	0	0	2	2	3	2	3	0	0	0	0	0	0	0	
04:00	32	0	1	0	9	13	7	2	0	0	0	0	0	0	0	
05:00	113	1	0	1	22	49	31	8	1	0	0	0	0	0	0	
06:00	204	3	1	8	39	70	58	19	6	0	0	0	0	0	0	
07:00	235	0	0	2	26	102	71	27	6	0	1	0	0	0	0	
08:00	193	1	0	0	26	71	72	22	1	0	0	0	0	0	0	
09:00	187	1	0	0	25	63	74	21	3	0	0	0	0	0	0	
10:00	276	1	1	2	33	118	91	25	5	0	0	0	0	0	0	
11:00	278	0	1	4	29	112	94	31	7	0	0	0	0	0	0	
12:00 pm	247	0	0	5	35	99	82	22	2	1	1	0	0	0	0	
01:00	315	1	0	10	47	142	98	15	2	0	0	0	0	0	0	
02:00	387	0	4	7	47	171	119	37	2	0	0	0	0	0	0	
03:00	399	2	4	6	52	193	117	23	2	0	0	0	0	0	0	
04:00	394	0	2	6	63	155	130	32	5	1	0	0	0	0	0	
05:00	277	0	2	5	53	130	66	21	0	0	0	0	0	0	0	
06:00	209	0	0	7	57	103	36	6	0	0	0	0	0	0	0	
07:00	199	0	3	3	41	109	38	4	1	0	0	0	0	0	0	
08:00	175	0	0	1	31	86	46	10	1	0	0	0	0	0	0	
09:00	78	0	0	0	10	35	25	8	0	0	0	0	0	0	0	
10:00	48	0	0	0	7	15	15	9	0	1	1	0	0	0	0	
11:00	44	0	0	0	1	25	9	5	3	1	0	0	0	0	0	
Day Totals	4333	10	19	69	662	1871	1293	352	49	5	3	*	*	*	*	*

Weather : Machine D (NB)
Counted by:
Board # : VEHICLE SPEEDS
Other :

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 000000051205
Start Date: 10/23/2001
File I.D. : C:\PROGRAM FI

Street name :HIGHLAND NB BETWEEN Cross street:SUNSET & JAY ST. A to B

Begin Time	Int. Total	0-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-9999
12:00 10/25	10	0	0	1	0	6	2	1	0	0	0	0	0	0	0
01:00	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0
02:00	5	0	0	1	0	2	1	1	0	0	0	0	0	0	0
03:00	13	0	0	0	4	4	3	2	0	0	0	0	0	0	0
04:00	29	0	0	1	5	14	4	4	1	0	0	0	0	0	0
05:00	117	0	1	1	23	42	34	14	2	0	0	0	0	0	0
06:00	197	6	4	6	40	71	52	14	4	0	0	0	0	0	0
07:00	251	0	0	4	46	98	67	29	6	1	0	0	0	0	0
08:00	230	0	0	5	28	102	73	19	2	1	0	0	0	0	0
09:00	207	1	1	3	28	83	65	21	4	1	0	0	0	0	0
10:00	268	0	1	5	43	109	73	31	5	1	0	0	0	0	0
11:00	219	0	0	0	24	71	90	30	4	0	0	0	0	0	0
12:00 pm	246	0	1	2	20	98	96	22	7	0	0	0	0	0	0
01:00	290	0	0	14	47	125	75	24	5	0	0	0	0	0	0
02:00	381	0	0	11	36	152	140	36	5	1	0	0	0	0	0
03:00	352	1	0	3	14	160	136	35	2	1	0	0	0	0	0
04:00	398	7	1	3	42	177	132	33	3	0	0	0	0	0	0
05:00	276	0	1	12	50	119	68	24	2	0	0	0	0	0	0
06:00	195	0	1	3	34	99	40	17	1	0	0	0	0	0	0
07:00	155	0	0	4	29	69	41	10	2	0	0	0	0	0	0
08:00	149	0	0	1	12	75	49	9	2	1	0	0	0	0	0
09:00	81	0	0	0	12	35	22	10	2	0	0	0	0	0	0
10:00	45	0	0	0	6	16	10	10	3	0	0	0	0	0	0
11:00	24	0	0	0	4	9	8	2	1	0	0	0	0	0	0
Day Totals	4141	15	11	80	547	1736	1284	398	63	7	*	*	*	*	*
12:00 10/26	11	0	0	0	1	6	3	1	0	0	0	0	0	0	0
01:00	12	0	1	0	0	3	6	2	0	0	0	0	0	0	0
02:00	8	0	0	0	0	3	3	1	1	0	0	0	0	0	0
03:00	15	0	0	1	0	4	5	4	1	0	0	0	0	0	0
04:00	29	0	0	2	11	7	6	1	1	0	1	0	0	0	0
05:00	115	0	1	1	23	56	18	15	1	0	0	0	0	0	0
06:00	163	8	1	11	49	49	41	4	0	0	0	0	0	0	0
07:00	238	0	0	11	33	94	67	29	3	1	0	0	0	0	0
08:00	196	2	3	4	19	91	55	20	2	0	0	0	0	0	0
09:00	192	1	2	2	23	63	75	23	3	0	0	0	0	0	0
10:00	54	0	0	1	8	25	13	4	1	0	0	0	0	0	2
Grand Total	11207	42	53	238	1635	4749	3340	974	150	17	4	0	0	0	5

*

Speed Statistics.

15th Percentile Speed :	28 MPH
Median Speed (50th percentile):	33 MPH
Average Speed - All Vehicles :	35 MPH
85th Percentile Speed :	38 MPH
95th Percentile Speed :	42 MPH
10 MPH Pace Speed :	31-40 MPH
Number of Vehicles in Pace :	8089
Percent of Vehicles in Pace :	72.19%
Number of Vehicles > 55 MPH :	9
Percent of Vehicles > 55 MPH:	.08%

Machine B (NB)
VEHICLE CLASSIFICATION

PROJECT: HIGHLAND AVENUE
LOCATION: MIDDLETOWN, NEW YORK
JCE JOB # 512

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 512000000333
Start Date: 10/23/2001
File I.D. : 512JA3

Street name :HIGHLAND NB Cross street:PROSPECT ST. & LINDEN PL. A to B

Begin Time	Int. Total	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11	Class 12	Class 13	Class 14	
12:00 10/23	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
01:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
02:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
03:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
04:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
05:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
06:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
07:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
08:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
09:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
10:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
11:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
12:00 pm	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
01:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
02:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
03:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
04:00	364	1	295	52	5	4	1	0	2	0	0	0	0	0	4	
05:00	453	0	375	65	0	6	0	0	1	0	0	0	0	0	6	
06:00	351	1	303	42	1	2	0	0	1	0	0	0	0	0	1	
07:00	270	1	232	32	0	1	0	0	0	0	0	0	0	0	4	
08:00	223	1	195	22	0	3	0	0	1	0	0	0	0	0	1	
09:00	195	0	182	12	0	0	0	0	0	0	0	0	0	0	1	
10:00	129	0	120	7	0	2	0	0	0	0	0	0	0	0	0	
11:00	75	0	70	5	0	0	0	0	0	0	0	0	0	0	0	
Day Totals	2060	4	1772	237	6	18	1	*	5	*	*	*	*	*	17	*
12:00 10/24	47	0	45	2	0	0	0	0	0	0	0	0	0	0	0	
01:00	23	0	22	0	0	0	0	0	0	0	0	0	0	0	1	
02:00	16	0	15	1	0	0	0	0	0	0	0	0	0	0	0	
03:00	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	
04:00	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	
05:00	16	0	14	2	0	0	0	0	0	0	0	0	0	0	0	
06:00	52	0	47	5	0	0	0	0	0	0	0	0	0	0	0	
07:00	149	0	108	36	1	3	1	0	0	0	0	0	0	0	0	
08:00	261	0	205	42	4	6	0	0	0	1	0	0	0	0	3	
09:00	245	0	179	52	3	8	1	0	0	0	0	0	0	0	2	
10:00	211	0	172	31	1	5	0	0	1	0	0	0	0	0	1	
11:00	226	0	180	36	1	5	0	0	1	0	0	0	0	0	3	
12:00 pm	304	0	245	52	0	4	0	0	3	0	0	0	0	0	0	
01:00	288	0	236	42	1	9	0	0	0	0	0	0	0	0	0	
02:00	313	0	264	33	2	11	0	0	0	0	0	0	0	0	3	
03:00	358	0	293	50	0	13	0	0	1	0	0	0	0	0	1	
04:00	421	1	336	69	6	7	0	0	0	0	0	0	0	0	2	
05:00	432	3	346	69	0	8	0	0	2	0	0	0	0	0	4	
06:00	370	3	306	54	0	4	0	0	1	0	0	0	0	0	2	
07:00	283	0	246	34	0	0	0	0	1	0	0	0	0	0	2	
08:00	224	0	198	25	0	0	0	0	0	0	0	0	0	0	1	
09:00	203	0	182	18	0	3	0	0	0	0	0	0	0	0	0	
10:00	149	0	133	14	0	1	0	0	1	0	0	0	0	0	0	
11:00	83	0	75	6	0	1	0	0	0	0	0	0	0	0	1	
Day Totals	4683	7	3856	673	19	88	2	*	11	1	*	*	*	*	26	*

Machine B (NB)

PROJECT: HIGHLAND AVENUE
LOCATION: MIDDLETOWN, NEW YORK
JCE JOB # 512

VEHICLE CLASSIFICATION

JOHN COLLINS ENGINEERS, P.C.
11 Bradhurst Avenue
Hawthorne, New York 10532

Site Code : 512000000333
Start Date: 10/23/2001
File I.D. : 512JA3
Page : 2

Street name :HIGHLAND NB Cross street:PROSPECT ST. & LINDEN PL. A to B

Begin Time	Int. Total	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11	Class 12	Class 13	Class 14
12:00 10/25	47	0	44	3	0	0	0	0	0	0	0	0	0	0	0
01:00	28	0	27	1	0	0	0	0	0	0	0	0	0	0	0
02:00	7	0	6	1	0	0	0	0	0	0	0	0	0	0	0
03:00	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0
04:00	6	0	5	1	0	0	0	0	0	0	0	0	0	0	0
05:00	19	0	17	2	0	0	0	0	0	0	0	0	0	0	0
06:00	50	0	39	9	1	1	0	0	0	0	0	0	0	0	0
07:00	159	1	122	31	1	4	0	0	0	0	0	0	0	0	0
08:00	258	0	198	50	5	5	0	0	0	0	0	0	0	0	0
09:00	248	0	188	45	2	10	0	0	2	0	0	0	0	0	1
10:00	235	0	181	45	1	7	0	0	0	0	0	0	0	0	1
11:00	253	0	198	41	2	8	0	0	3	0	0	0	0	0	1
12:00 pm	277	1	233	39	2	2	0	0	0	0	0	0	0	0	0
01:00	236	0	191	38	1	5	0	0	1	0	0	0	0	0	0
02:00	284	0	230	41	1	8	0	0	2	0	0	0	0	0	2
03:00	344	0	276	49	1	12	0	0	1	2	0	0	0	0	3
04:00	365	0	309	41	7	7	0	0	0	0	0	0	0	0	1
05:00	414	0	345	65	0	4	0	0	0	0	0	0	0	0	0
06:00	373	1	314	53	0	3	1	0	0	1	0	0	0	0	0
07:00	262	0	218	41	0	1	0	0	0	0	0	0	0	0	2
08:00	204	0	177	26	0	1	0	0	0	0	0	0	0	0	0
09:00	168	0	151	17	0	0	0	0	0	0	0	0	0	0	0
10:00	140	0	127	12	0	1	0	0	0	0	0	0	0	0	0
11:00	77	0	74	3	0	0	0	0	0	0	0	0	0	0	0
Day Totals	4457	3	3673	654	24	79	1	*	9	3	*	*	*	*	11 *
12:00 10/26	41	0	37	4	0	0	0	0	0	0	0	0	0	0	0
01:00	21	0	21	0	0	0	0	0	0	0	0	0	0	0	0
02:00	11	0	10	1	0	0	0	0	0	0	0	0	0	0	0
03:00	14	0	10	2	0	0	0	0	0	0	0	0	0	0	2
04:00	8	0	6	2	0	0	0	0	0	0	0	0	0	0	0
05:00	18	0	13	3	0	1	0	0	0	0	0	0	0	0	1
06:00	48	0	42	5	1	0	0	0	0	0	0	0	0	0	0
07:00	152	0	110	37	1	3	0	0	0	0	0	0	0	0	1
08:00	240	1	182	48	3	4	0	0	0	0	0	0	0	0	2
09:00	233	1	165	55	2	8	0	0	1	0	0	0	0	0	1
10:00	207	0	166	33	1	5	0	0	0	0	0	0	0	0	2
11:00	232	1	177	39	0	14	0	0	1	0	0	0	0	0	0
12:00 pm	92	1	77	10	2	0	0	0	0	0	0	0	0	0	2
Totals	12517	18	10317	1803	59	220	4	0	27	4	0	0	0	0	65
Percent		.1%	82.4%	14.4%	.4%	1.7%	.0%	.0%	.2%	.0%	.0%	.0%	.0%	.0%	.5%

APPENDIX "F"

EXCERPTS FROM NYSDOT HIGHWAY DESIGN MANUAL - TRAFFIC CALMING

HIGHWAY DESIGN MANUAL

Chapter 25 - Traffic Calming

Revision 33

August 31, 1998

CHAPTER 25
TRAFFIC CALMING

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25.1 INTRODUCTION

Traffic calming measures have been used successfully in Europe for many years. The number of successful traffic calming programs in the United States is increasing, and reports of these successes are generating strong interest in New York State. Traffic calming techniques were first used to stem the rise of speeds and accidents, and to improve the environment in residential settings. Since then, they have been used in other situations with some success.

Practitioners have found that increased public awareness of traffic calming is resulting in a call to use it to resolve many traffic problems. However, traffic calming cannot solve all traffic problems. The Region, in cooperation with the local community, should examine the project circumstances, establish the project objectives, and consider if traffic calming should be an alternative or an element of the design.

A Department task force developed a policy statement and guidance on traffic calming to assist Regions through the process. Section 25.2 contains the policy statement, policy scope, and the definition and background of traffic calming. Section 25.3 contains general guidance and requirements, including general considerations. Section 25.4 provides some examples of objectives that could be achieved by traffic calming. Section 25.5 lists example "test questions" to help determine if traffic calming is viable. Section 25.6 explains the applicability of traffic calming techniques, and describes the speed categories established specifically for traffic calming measures. Section 25.7 outlines the importance of community involvement and the process that should be followed. Section 25.8 covers project monitoring and its importance in evaluating the effectiveness of the project. Appendices A, B, and C are excerpts from guidelines developed for the Washington State Department of Transportation, the Florida Department of Transportation, and the City of San Buenaventura, CA, respectively. They are provided for guidance until such time as formal guidelines or standards are adopted by the Department.

25.2 TRAFFIC CALMING POLICY

25.2.1 Policy Statement

The Department's policy is to consider the application of traffic calming, as appropriate, on State highways and Department administered or financed projects, in accordance with the guidelines and requirements contained in this chapter.

25.2.2 Scope

The policy provides requirements and guidance for the Department's planners, scopers, designers, and traffic engineers; formally states positions on application of traffic calming measures; and indicates the process to be used to consider them.

25.2.3 Definition

Traffic calming is the combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behavior, and improve conditions for nonmotorized street users.

NOTE: The Department is adopting the above proposed Institute of Transportation Engineers (ITE) definition of traffic calming due to the desirability of having a consistent definition and because it is sufficiently broad to allow for the concept that the needs of the motorist and nonmotorist must be balanced, appropriate to the intended function of a given facility or area.

NOTE: The ITE describes the meaning of the phrases in the definition as follows: 1) reduce negative effects of motor vehicle use means changing the design and the role of the street to reduce the negative social and environmental effects of motor vehicles on individuals (e.g., speed, intrusion, etc.), and on society in general (e.g., pollution, urban sprawl, etc.); 2) altering driver behavior addresses the self enforcement aspect of traffic calming; the lowering of speeds, the reduction of aggressive driving, and the increase in respect for nonmotorized street users; 3) improve conditions for nonmotorized street users means to promote walking and cycling, increase safety, create a feeling of safety, and improve aesthetics, etc.

25.2.4 Background

Individual traffic calming techniques are not, for the most part, new. Some, such as pedestrian refuge islands and traffic circles, have been used since the days of horse drawn carriages. Most techniques are used in one form or another with varying frequency on highways, streets, or private property. What is new is the interest in applying these techniques in combination, and improving the compatibility among all highway users. Combining techniques is especially effective in neighborhood traffic calming, which applies to residential neighborhoods, and on shopping or entertainment oriented streets, and in some cases main streets of cities, villages, and hamlets, and school zones.

25.3 GENERAL GUIDANCE AND REQUIREMENTS

The policy and guidance in this chapter create a hierarchy for the application of traffic calming techniques which strives to consider and balance the many conflicting needs between the highway users (motorists, pedestrians, bicyclists) and adjacent land owners, with safety being of paramount concern. Wherever possible, existing standards, basic design principles, ongoing research, and past experiences have been used to develop the policy and guidance. Often both the State and local highway systems will be affected and coordination is needed during scoping and early design phases. It is essential to determine, during scoping, if traffic calming measures are warranted and implementable, or if traditional approaches or strategies are more appropriate. Refer to Section 25.5 for guidance in when traffic calming should be considered.

Whenever possible, traffic calming measures shall be designed in accordance with all applicable standards, criteria, and guidelines. When a design speed is selected that is less than the value obtained using the methodology in Chapter 2 of this manual, it shall be considered a traffic calming effort and the requirements or guidance in this chapter will apply. However, each situation is unique and professional judgement must be exercised. Refer to Chapter 1, Chapter 2, Section 2.8, and Chapter 5, Section 5.1 of this Manual, and Sections 25.5 and 25.6.3 in this chapter for further guidance on how to deal with variations from this Manual and design exceptions.

A caution: in some localities across the country, traffic calming is being embraced as a cure-all. Some of the techniques suggested in the literature were tried and discarded (some in the 1940's or 1950's). Other techniques have been developed in other countries with different cultural attitudes and often lower vehicle volumes on even the most heavily traveled roads. These reasons, in combination with different laws and penalties, may have significant effect on the success of a particular technique.

While a fresh look at some techniques is appropriate, effort should not be wasted reinventing the wheel. It is costly monetarily, and sometimes from a safety point of view, to experiment. Consequently, it is well worth the extra effort to search old literature and old department records, and to talk to experienced department staff, to determine why a particular technique is no longer used and what was wrong with particular aspects of it, either in design or application. Also, it may be possible to observe a similar installation or to find a before and after study of a recent installation.

Caution should be exercised in reintroducing any technique that has a proven negative safety record. For example, the once popular traffic circles (rotaries) were dropped from AASHTO's *A Policy on Geometric Design of Highways and Streets*, 1984 for reasons of safety, capacity, and driver confusion. Many have been removed or are now controlled by signals. Now, there is renewed interest in the new version called the modern roundabout, which has some design changes from the old traffic circle. However, these changes may not address some of the inherent problems with traffic circles, such as those related to use by large trucks or recreational vehicles, or driver confusion on multilane circles. There are also mixed opinions on safety and capacity issues which need to be investigated further before any policy on the use of modern roundabouts is issued.

Experience in other localities indicate successes, especially for low speed, local street situations where a single lane modern roundabout is adequate for the traffic volumes. With respect to multilane roundabouts, the prudent course of action would be to modify existing traffic circles with known operational problems to the modern roundabout design in order to determine if the new designs are in fact as effective as claimed. Considering the negative operational history with multilane traffic circles, new versions should not be built if the techniques will not remedy the problems on existing ones. In the interim, until a policy is developed, any proposal for a roundabout should be developed on a case-by-case basis with input from the Main Office. This will help in the formulation of a policy and enable the dissemination of the latest information on techniques and experiences of other Regions.

Traffic calming techniques, when appropriately installed, can supplement law enforcement activities. However, they cannot replace the need for, or the obligation to provide normal law enforcement.

In general, the Department, in collaboration with the affected locality and within the framework of this policy, will consider traffic calming measures as a tool to address congestion, safety, and quality of life issues in response to one or more of the following:

1. A community, corridor or area where a traffic calming plan has been completed, or agreed upon, by a neighborhood group, the municipality, the county.
2. A project is scheduled for a village/main street, school zone or other subarea and scoping indicates that inclusion of traffic calming would satisfy identified subarea needs such as a significant existing accident problem whose severity could reasonably be expected to be reduced by the application of traffic calming.
3. Community requests for speed limit modifications, traffic control devices, safety improvements or other concerns are not satisfied by more traditional measures and/or enforcement. The community must, however, be aware that traffic calming does not replace their obligation to provide normal law enforcement.

For additional guidance in when traffic calming can be considered, refer to Section 25.5.

Drivers should be warned before they enter, and when they drive through, a traffic-calmed area. Isolated and unanticipated street narrowing, tight curves or reduced sight distances could be potential hazards if encountered without warning.

In addition to concerns for motorists' safety, public safety concerns must be addressed. The most obvious of these are access for fire vehicles and response times for fire, ambulance and police traffic. The main concern is how traffic calming may affect them.

When the implementation of traffic calming causes drivers to divert to use alternate routes, it will likely lead to increased volumes (and perhaps speeds) on those routes. Projects that will result in significant diversions of traffic to alternate routes should be developed in accordance with the following:

1. Traffic calming plans shall not be developed without the opportunity for input from people who live or work along the alternate routes to which traffic will be diverted. Refer to Section 25.7.1.2.
2. Traffic calming techniques that are likely to reduce capacity should only be used on local streets or neighborhood streets to avoid serious congestion. Capacity reducing techniques should not be used for other highway types unless a reasonable, logical alternative route is readily available or is provided before the project or as part of it. If there is clearly excess capacity so that capacity reduction will not be a problem, such techniques may be considered. In some situations, the alternate route should be clearly signed.
3. Area-wide traffic management/calming plans to ameliorate the potential impact of any traffic diversion as a consequence of the traffic calming activities should be considered, particularly in urban settings.
4. Traffic calming should only be employed over limited lengths of a given collector or arterial that meet all other requirements for treatment. For local roads, it should only be used where it is important to give priority to residential area character or to nonmotorized users of the roadway.

Consider installing temporary, more forgiving traffic calming measures such as pavement markings, temporary delineators or channelizing devices on a trial basis, when appropriate, before installing the permanent measures, particularly in those situations where traffic calming may require significant driving adjustments. Temporary deployment will provide a transition to the permanent measures proposed, an insight into the effectiveness of the proposed calming measures, and the opportunity to make modifications before installing a permenent device.

It is desirable to use forgiving, frangible, or crashworthy traffic control devices, plantings, etc., for permanent traffic calming measures. Design speed, traffic, pedestrian and bicycle volumes, project geometrics, and aesthethics are factors to be considered in determining the treatment to be used.

The trial period should be developed and implemented with the concurrence of, and in coordination with, the locality. The trial measures should encompass all the affected highway and mainline and side street approaches as deemed appropriate by agreement between the Department and the locality. The trial period should be long enough to evaluate the effectiveness of the measures and acclimate highway users through the full range of traffic (commuter, tourism, commercial) and environmental (snow and ice control) conditions expected. Refer to Appendix A, p. 40 for additional guidance on temporary installations.

Finally, traffic calming plans, especially those that involve neighborhood traffic calming, require the complete cooperation and support by the affected local citizens if the plans are to be successful.

25.4 TRAFFIC CALMING PROJECT OBJECTIVES

A project's needs determine what objectives should be achieved by alternatives. Examples of objectives that may be achieved by traffic calming measures include:

- Improve driver behavior to be more considerate of other users of the street or road,
- Increase the level of respect for nonmotorized street users,
- Create a feeling of safety for all street users,
- Improve safety and convenience for road users, including residents, motorists, bicyclists, pedestrians, transit riders, and people with disabilities.
- Reduce number and/or severity of accidents.
- Reduce noise and air pollution (see NOTE below).
- Provide space for non-traffic activities (e.g., shopping, rest, and play).
- Enhance street appearance and reduce, where possible, the number of traffic signs. (Traffic control measures require signing and may increase the number of signs.)
- Achieve an overall improvement in the environment.
- Reduce speeds of motor vehicles where incompatible with adjacent land use.
- Reduce need for police enforcement.
- Reduce short-cut motor vehicle traffic.
- Mitigate the impact of vehicular traffic on residential neighborhoods.
- Promote and support the use of transportation alternatives to the single occupant vehicle.
- Achieve an overall improvement of the community's quality of life.

NOTE: Some traffic calming measures may not reduce air pollution. If the objective of a project is reduced air pollution, the appropriate analysis should be conducted to prevent unintended consequences.

25.5 WHEN TRAFFIC CALMING SHOULD BE CONSIDERED AS AN ALTERNATIVE

Traffic calming is not applicable to every project. Projects should be assessed to determine if traffic calming is a feasible alternative. The following are examples of "test questions" to assist the designer or scoper in this determination. All questions are not necessarily applicable to all projects. Only those that do apply should be selected. If a majority of the responses are affirmative, traffic calming should probably be considered as an alternative. The questions are categorized according to whether they involve local community support, traffic conditions or diversions, mobility or safety issues, design measures, or other conditions.

Local Community Support

- Requested by Local Community
  - Has traffic calming been requested by users, residents, or other affected local citizens?
  - Has the locality requested or initiated a traffic calming study or prepared a plan to improve circulation, safety, etc., in a congested area, or on the whole network?
  - Is there a local desire to create a more livable community by improving the urban environment through motor vehicle speed and/or volume control?
  - Is there a local desire to develop, improve, or enable diversified travel mode choices for travelers?
  - Are there continuous requests from local residents for speed limit reductions?

- Support of Local Community, Agencies, Services
  - Will emergency services approve the use of traffic calming on other than principal evacuation, fire, and ambulance routes?
  - Does traffic calming have the approval of local business and transit operators?
  - Is there a joint NYSDOT/local agreement on what the problems are and that there is need to address them with traffic calming measures?
  - Is there is broad-based community and local government support for traffic calming?
  - Have the local citizens been given every opportunity for involvement in solving the problem?

- Comply With Master Plan and Zoning Ordinance
  - Is the solution part of, and in accordance with the local master plan?
  - Are the appropriate land use and zoning ordinances in effect in the local community?
  - Does the local government have a comprehensive plan to address the direct and indirect effects of implementing traffic calming on a particular facility, i.e., the effects of traffic diversion, the effects on emergency vehicle routes, congestion, etc.?

Traffic Conditions/Mobility/Safety

- Traffic Operations/Conditions
  - Are there significant pedestrian/bicycle traffic generators (schools, community or recreational facilities) located on the street?
  - Is there widespread non-compliance with existing speed limits?
  - Is there excessive through traffic on local and collector roads?
  - Would known circulation problems in and around the right of way, or in the corridor of a project on a "Main Street" require an area wide solution?

- Mobility
  - What is the roadway's relationship or importance to an area and can NYSDOT accept the potential loss of service quality associated with traffic calming?
  - Would the use of traffic calming complement the intended function of the route?

- Safety
  - Are there concerns for speeding, pedestrian safety, or other issues at locations where warrants for traffic signals or stop signs are not met?
  - Would the use of traffic calming be detrimental to safety?
  - Are there accidents between autos, bicycles, and pedestrians?
  - Are there parking and deparking accidents?
  - Would known safety problems in and around the right of way, or in the corridor of a project on a "Main Street" require an area wide solution?

- Diversion
  - Can diversions be accommodated?
  - Are diversions appropriate?
  - Are adequate alternate routes available?
  - Are alternate routes consistent with the comprehensive plan for managing traffic through the community?
  - Will the introduction of traffic calming measures on a roadway adversely affect adjoining roadways?

Design Measures

- Standards
  - Would the use of traffic calming violate standards, policies, rules, or regulations?
  - Can its use be justified by the exception process? (See Chapter 2, Section 2.8 and Chapter 5, Section 5.1 of this Manual.)
  - Will the traffic calming measures conform to the Americans with Disabilities Act Accessibility Guidelines (ADAAG)?

- Traditional Alternatives
  - Will traditional design approaches achieve the identified project objectives?

Other Conditions

- Will school districts be negatively affected?
- Will traffic calming be detrimental to economic growth?
- Will the proposed traffic calming measures undergo a trial period?
- Is there a decline in quality of life due to perceived imbalance in travel modes?
- Are alternate modes of travel available?
- Is there a local access management policy and/or a local land use policy that will complement traffic calming?
- Does a State arterial function as the "Main Street" of a local community?
- Are there multi-modal circulation problems over a subarea or a network that could be resolved by traffic calming?
- Are problems in the project area directly related to inappropriate driver behavior?

25.6 APPLICABILITY OF TRAFFIC CALMING TECHNIQUES

Traffic calming measures can be divided between those that 1) use physical restrictions to lower the speed at which a reasonable and prudent driver feels safe and comfortable, and those that 2) convey the message that priority is given to creating a pedestrian and resident-friendly setting, possibly with special accommodations for bicyclists. Measures in the former group include speed humps and tables, lane constrictions (including neck-downs to a single lane), chicanes, tight curves, turning radius reductions, and sight distance limitations. Measures in the latter group (message or ambiance techniques) include aesthetic treatments such as landscaping with trees and other plants; use of special paving and/or markings; decorative benches, light poles, fountains, and sculptures and/or kiosks; accommodations such as sidewalks, pedestrian bulb-outs, mid-block crosswalks, and bicycle lane markings; and distinctive entrances (gateways) as demarcation for the traffic-calmed area.

For the purpose of application of this policy and guidance, the highway system is divided into four general speed categories, Category I through Category IV, as described below. Category II is subdivided into "Local Streets and Roads", as defined in Chapter 2 of this Manual, and "All Other Streets and Roads", for one of the higher functional classifications. Roads on the New York State highway system are generally covered by Category II, Subcategory "All Other Streets and Roads", Category III, and Category IV. All speed categories are applicable to streets and roads not on the New York State highway system. The suitabilities of the techniques for each of the categories are shown in Table 25-1.

Illustrations and descriptions of many of the traffic calming measures inTable 25-1 can be found in the appendices.

25.6.1 Category I Facilities

Intended or desired vehicle operating speed is in the range of 25 km/h (15 mph) to less than 40 km/h (25 mph).

Preservation or enhancements of neighborhood or area character and/or accommodation of bicyclists and pedestrians are the primary functions of such streets or roads. Examples include neighborhood streets, and areas intended for shopping, recreation, or entertainment activities where the intended or preferred transportation modes are walking or bicycling. These are the types of facilities where traffic calming techniques have the greatest applicability and will receive the greatest support from the community as a whole.

Since it is not legal or practical to create a speed limit less than 40 km/h (25 mph), except for school speed limits, speed control and eliminating or discouraging through traffic is achieved by physical means in combination with appropriate warning signs (refer to Category III, *Reduced Operating Speeds*). Design speed measurements using the methodology in Chapter 2 of this Manual would not normally find speeds that fall within the range of this category. They are achievable only after the implementation of certain traffic calming techniques.

Many techniques can be used where there is a demonstrated problem and normal enforcement has been unsuccessful. These include such features as vertical and lateral shifts, street narrowing, medians, one-way restrictions, and reduced corner radii. See Table 25-1 and related information for suitability of various traffic calming techniques.

Where the intent is to significantly reduce through vehicle trips, suitable alternative routes must exist or they must be constructed and opened before implementation of the traffic control measures.

25.6.2 **Category II Facilities**

Design speed ranges from 40 km/h (25 mph) to less than 60 km/h (35 mph) as determined in accordance with Chapter 2 in this Manual, or as established for Local Streets and Roads (refer to Category III, *Reduced Operating Speeds*).

Included in this grouping are most through streets in urban or suburban areas, villages, hamlets, and main roadways in developments. This category is subdivided into "Local Streets and Roads", as defined in Chapter 2 of this Manual, and "All Other Streets and Roads" which includes all other classifications, and generally applies to the roads on the New York State highway system.

Speed control and safety is normally accomplished by routine enforcement. Where data shows this effort is not effective, enforcement can be supplemented by speed-timed progressive signal systems, chicanes (designed for local streets ≤ 50 km/h [30 mph]), pedestrian refuge islands, walk phases on signals, gateways, sidewalk extensions at intersections, patterned and/or colored crosswalks, and other street ambiance enhancing features. See Table 25-1 for suitability of various traffic calming techniques. Refer to Chapter 5, Section 5.10.4.3 of this Manual for the design requirements for pedestrian refuge islands.

25.6.3 **Category III Facilities**

Design speed is 60 km/h (35 mph) to less than 80 km/h (50 mph) as determined in accordance with Chapter 2 of this Manual.

This is undoubtedly the most varied of groupings with respect to mix of vehicles, pedestrians, and bicyclists, with most types of roads being represented. This group includes, but is not limited to:

1. Some parkways,
2. Urban or suburban arterials and collectors,
3. Most state highways, county or town roads as they pass through small suburban or rural communities, and
4. Some higher speed urban streets whose primary function is to move large volumes of vehicular traffic at higher speeds.

The number of bicyclists or pedestrians will vary widely (including seasonal variations). Some of the techniques that will achieve speed reduction or improve safety would include, where applicable, progressive traffic signal systems, pedestrian refuge islands, walk phases on signals, gateways, patterned and/or colored crosswalks, and other street ambiance enhancing features. See Table 25-1 and related information for suitability of various traffic calming techniques. Refer to Chapter 5, Section 5.10.4.3 of this Manual for the design requirements for pedestrian refuge islands.

Attempts at creating speed limits which are inconsistent with driver expectations and habits are ineffective, inappropriate, and potentially unsafe because they create a wide variance in operating speeds and are generally ignored. Speed limits inconsistent with anticipated operating speeds (85th percentile) will be unsuccessful unless there is heavy, continued enforcement.

Reduced Operating Speeds

It may be possible to reduce operating speeds for some projects as part of a traffic calming effort. A local road or street, and in some instances a state highway, may have an existing operating speed far in excess of the speed limit or the desired operating speed. Application of the methodology in Chapter 2 of the HDM would produce a design speed comparable to the existing speeds. However, consistent with the spirit and intent of the design speed discussion in the 1994 AASHTO "A Policy on Geometric Design of Highways and Streets", page 62, it may be acceptable and consistent with good engineering practice to progress, as exceptions to design standards, a design which will lower the anticipated operating speed. The design speed could then be based on the lower anticipated operating speed.

To progress the design as an exception to the normal process for establishing anticipated operating speed, the designer must clearly demonstrate and document the following as appropriate:

1. That the existing operating speeds and/or volumes are clearly inconsistent with the intended use and function of the road, e.g., a residential street that is being used as a short cut between arterial and/or collector highways, while similar adjacent streets function as intended.
2. That there is an existing accident problem, or that the number of pedestrians and/or bicyclists that currently use or would use the facility are significant and there is a potential for safety problems.
3. That the proposed design will clearly affect the existing operating speeds and the Regional Traffic Engineer (RTE) supports the design and agrees reductions in operating speed will occur. The burden is on the designer to provide an engineering analysis to demonstrate that the elements of the proposed design will reduce the operating speeds. The devices that may be used include geometric alternatives such as the introduction of a series of horizontal curves, installation of signing, use of traffic calming devices consistent with the new anticipated operating speed, and any other recognized and accepted technique with a proven track record in reducing speeds without compromising safety.

   From another perspective, traffic calming features that restrict travel on Category III facilities would essentially build potential problem areas into a road. Great care must be exercised to ensure that attempts at speed reduction do not simply make the road less safe without actually reducing operating speeds to levels consistent with the safe operating speed for the design. This applies to a lesser degree to Categories I and II, and to a greater degree to

Category IV.

Where it is determined that speed reducing efforts will not be appropriate, the designer should consider traffic calming techniques that are intended to improve conditions for nonmotorized users and residents without directly impacting vehicle operation.

4. That the gradual transition of roadside treatments to this area from a Category IV area can be accomplished safely, consistent with currently accepted practice, e.g.,:
   - through the use of gradual reductions in clear area;
   - by the introduction of traversable curb at the back of shoulder, to loss of shoulder, to change to barrier curb;
   - by the introduction of transitional horizontal curves that step speeds down;
   - with the use of speed x width (S x W) tapers for lane width reductions.
5. That appropriate regulatory and warning signs will be installed as necessary.
6. That the project will be monitored by the Region or the locality after construction. (See Section 25.8.)
7. That all applicable standards, policies, rules and regulations will be followed.

25.6.4 <u>Category IV Facilities</u>

Design speed is 80 km/h (50 mph) or greater as determined in accordance with Chapter 2 of this Manual.

Included are interstates, freeways, high speed parkways, arterials, expressways and all other high speed roads where priority is given to motorized vehicles either by prohibiting nonmotorized access, by providing shoulders that bicyclists or pedestrians may use, or by providing separate facilities.

The selection of traffic calming measures, where bicycles or pedestrians are allowed, is limited and consists primarily of warning or regulatory signs to alert the motorist of designated bike routes or crossing points for pedestrians or bicycles. Roadside development, such as businesses or recreational areas, may also serve to alert motorists of the possibility of the presence of bicyclists or pedestrians. Some of the suitable techniques include pedestrian refuge islands, certain streetscaping devices, some route modifications, and traffic control devices. See Table 25-1 and related information for suitability of various traffic calming techniques. Refer to Chapter 5, Section 5.10.4.3 of this Manual for the design requirements for pedestrian refuge islands.

Consideration should be given to providing adequate shoulder width for bicycles and pedestrians to use, as appropriate.

Attempts at creating speed limits inconsistent with driver expectations and habits are ineffective, inappropriate, and potentially unsafe because they create a wide variance in operating speeds. Speed limits inconsistent with anticipated operating speeds (85th percentile) will be unsuccessful unless there is heavy, continued enforcement.

Table 25-1 Suitability of Traffic Calming Features for Speed Categories

TRAFFIC CALMING FEATURES	CATEGORY I (NEIGHBORHOOD) (25-39 km/h)	CATEGORY II (40-59 km/h)		CATEGORY III (60-79 km/h)	CATEGORY IV (≥80 km/h)	SPEED REDUCTION[1]	VOLUME REDUCTION[1]
		LOCAL[2] STREETS OR ROADS	ALL OTHER STREETS OR ROADS				
VERTICAL SHIFTS [3]							
Raised Crosswalks	SUITABLE	SUITABLE ≤50 km/h NOT RECOMMENDED >50 km/h	NOT RECOMMENDED	NOT PERMITTED		YES	POSSIBLE
Raised Intersections							NO
Speed Cushions							NO INFORMATION
Speed Humps [4]							POSSIBLE
Speed Tables							
LATERAL SHIFTS							
Alternate Side Parking	SUITABLE			NOT PERMITTED		LIKELY	POSSIBLE
Chicanes/Serpentine		SUITABLE ≤50 km/h NOT RECOMMENDED >50 km/h	NOT RECOMMENDED			YES	

See General Notes and Endnotes following this table.

See §25.6

Table 25-1 Suitability of Traffic Calming Features for Speed Categories (continued)

TRAFFIC CALMING FEATURES	CATEGORY I (NEIGHBORHOOD) (25-39 km/h)	CATEGORY II (40-59 km/h)		CATEGORY III (60-79 km/h)	CATEGORY IV (≥80 km/h)	SPEED REDUCTION[1]	VOLUME REDUCTION[1]
		LOCAL[2] STREETS OR ROADS	ALL OTHER STREETS OR ROADS				
CONSTRICTIONS							
Neckdowns, Chokers [6]	SUITABLE		NOT RECOMMENDED	NOT PERMITTED		SLIGHT	NO
1-Way Entry/Exit Choker, Half Closure, Semi-Diverter						YES	YES
Curb Extensions at Intersections			SUITABLE*			SLIGHT	NO
Pedestrian Refuge/Midblock Islands			SUITABLE				
Driveway Link	SUITABLE	NOT PERMITTED				YES	YES
Single Lane Slow Point							
Single Lane Angled Slow Point							
Two-Lane Slow Point		NOT RECOMMENDED					
Two-Lane Angled Slow Point							
NARROW PAVEMENT WIDTHS							
Pavement Narrowing	SUITABLE		NOT RECOMMENDED	NOT PERMITTED		POSSIBLE	POSSIBLE
ENTRANCE FEATURES							
Gateways	SUITABLE				NOT PERMITTED	YES	YES

*Suitable only with upstream parking.
See General Notes and Endnotes following this table.

See §25.6

Table 25-1 Suitability of Traffic Calming Features for Speed Categories (continued)

TRAFFIC CALMING FEATURES	CATEGORY I (NEIGHBORHOOD) (25-39 km/h)	CATEGORY II (40-59 km/h)		CATEGORY III (60-79 km/h)	CATEGORY IV (≥80 km/h)	SPEED REDUCTION[1]	VOLUME REDUCTION[1]
		LOCAL[2] STREETS OR ROADS	ALL OTHER STREETS OR ROADS				
RELATED STREETSCAPING							
Color Contrast or Patterns/Markings	SUITABLE					POSSIBLE	NOT LIKELY
Landscape Development							NO
Sidewalks, Shoulders						NO INFORMATION	
Street Furniture and Lighting						POSSIBLE	
Surface Textures					NOT RECOMMENDED		NOT LIKELY
Shared Zones		NOT RECOMMENDED		NOT PERMITTED			NO INFORMATION
UNCATEGORIZED MEASURES							
Supplementary Pedestrian Crossing Channelization Devices [6]	SUITABLE	SUITABLE (40-49km/h) NOT PERMITTED (50-59km/h)		NOT PERMITTED		NO INFORMATION	
Back-in Diagonal Parking [7]		NOT RECOMMENDED					
Reduced Intersection Radii						YES	
Single-Lane Roundabouts			**	**			NOT LIKELY
Multiple-Lane Roundabouts	**	**	**	**		NO INFORMATION	

**Any proposal for a roundabout should be developed on a case-by-case basis with input from the Design Quality Assurance Bureau.
See General Notes and Endnotes following this table.

See §25.6

Table 25-1 Suitability of Traffic Calming Features for Speed Categories (continued)

TRAFFIC CALMING FEATURES	CATEGORY I (NEIGHBORHOOD) (25-39 km/h)	CATEGORY II (40-59 km/h)		CATEGORY III (60-79 km/h)	CATEGORY IV (≥80 km/h)	SPEED REDUCTION[1]	VOLUME REDUCTION[1]
		LOCAL[2] STREETS OR ROADS	ALL OTHER STREETS OR ROADS				
ROUTE MODIFICATIONS							
Arterial Improvements	SUITABLE					NO INFORMATION	
Bike Facilities						POSSIBLE	
Median Treatments						LIKELY	YES
Modified Intersection, Channelization						NO INFORMATION	
One-Way Operation						NO	MINOR
Truck Prohibitions			NOT RECOMMENDED	NOT PERMITTED		YES	YES
Cul-de-sacs, Full Closures						LIKELY	YES
Diverters							
TRAFFIC CONTROL DEVICES							
Higher Visibility Crosswalks [8]	SUITABLE					POSSIBLE	NO
Signing						POSSIBLE	
Progressive Traffic Signal Systems						POSSIBLE	
Walk Phase on Signals						NO	
Regulations/Enforcement						LIKELY	

See General Notes and Endnotes following this table.

See §25.6

General Notes to Table 25-1

• Those measures shown as "NOT RECOMMENDED" may be considered in case-specific projects.
• Generally, traffic calming measures should not be used on principal emergency response routes. Their proposed use should be coordinated with and approved by the local police/fire/emergency medical services.
• Slow point constrictions may include one or more traffic calming measures.
• Gateways are generally a combination of traffic calming measures.

Endnotes to Table 25-1

1. This information is based on the experience of others who have implemented traffic calming and have monitored the results. Individual results may be influenced by the combination of traffic calming measures used, the frequency of their use, the speed category and the intended function of the facility or area, and other factors. Taken from *A Guidebook for Residential Traffic Management* and also *Neighborhood Traffic Management and Calming Program.*

2. As defined in Chapter 2 of this Manual.

3. Speed humps/bumps are not used on New York State highways to control speed (D.J. Russo, Operations Bureau letter to M. Weithorn, August 6, 1995). These guidelines extend this restriction to include all vertical shift measures. Use of vertical shifts on local roads is subject to the approval of the local authority having jurisdiction.

4. Refer to *Guidelines for the Design and Application of Speed Humps.*

5. In locations where no parking is provided, lane drop tapers should precede neckdowns or chokers.

6. Refer to NYSDOT's guidance on Supplementary Pedestrian Crossing Channelization Devices (T.C. Werner memo to Regional Traffic Engineers, July 15, 1997).

7. The following dimensions were adapted from the *Traffic Engineering Handbook*, 1992, Figure 7-1 and Table 7-5 for 3.0 m wide parking spaces and 60° angle parking:
   a. 2 lanes, 2-way, angle parking both sides, minimum pavement width 19.0 m curb-to-curb.
   b. 2 lanes, 2-way, angle parking one side, minimum pavement width 13.5 m curb-to-curb.
   c. 1 lane, 1-way, angle parking one side, minimum pavement width 9.5 m curb-to-curb.

8. Crosswalk markings must be white, in accordance with the *NYS Manual of Uniform Traffic Control Devices.*

See §25.6

25.7 COMMUNITY INVOLVEMENT

In those communities that have them, traffic calming programs are conducted to respond to complaints and requests from local residents concerned about the safety, noise, pollution, and visual impacts of cars, trucks, and buses on their street. Most traffic calming programs are geared for residential areas on residential streets, or shopping or entertainment oriented streets where, in the perception of the residents or users, those impacts are affecting their quality of life.

Community involvement may be the most important element in a successful traffic calming project. Close community involvement enables planners/designers to see the problem from the local perspective. It also helps the community understand the impacts of traffic calming measures and the constraints within which the project must be developed. Several meetings should be held with the affected residents, from the time a problem is recognized and identified until the completed project has been evaluated. Without community involvement, the solution to a problem may not satisfy the needs of the community or the project, and result in failure.

25.7.1 The Process

A project is initiated when the scoping process begins for a project on the Region's program, or when local residents request traffic calming be considered an alternative solution to traffic problems on their street or road. Projects should be assessed early in the scoping phase to determine if traffic calming should be considered. Not all projects are candidates for traffic calming. Refer to Section 25.5 for examples of "test questions" to assist in determining if traffic calming should be considered as a project alternative. Examples of traffic calming objectives can be found in Section 25.4.

Input should be solicited from the potentially affected parties during the planning and design of traffic-calmed facilities. The following list of potential parties is not limiting, nor is contact necessarily appropriate or required for all parties.

1. Residents, owners, and store operators (local populace) on the street.
2. Local populace on the street(s) to which traffic may be diverted.
3. Police, fire, ambulance and sanitation officials.
4. Transit authorities.
5. Local truck delivery companies.
6. Municipal planning organizations.
7. The organization with final maintenance jurisdiction.
8. Utility companies.

The activities described below are suggested guidelines for community involvement when considering traffic calming for projects. It is intended that they be coordinated with, but not replace, the normal scoping phase and Design Phases I-IV public involvement activities, as described in the Scoping Procedure Manual and the Design Procedure Manual.

25.7.1.1 Scoping Phase

When the Region initiates a project and traffic calming has not been requested by local representatives/residents prior to the start of the scoping phase, the Region should inform them that a project is to be undertaken, and solicit their input regarding traffic problems, issues, and project needs, for consideration in the development of the project scope.

When traffic calming has been requested by local representatives/residents prior to the start of, or during the scoping phase, the Region should solicit local input regarding traffic problems, issues, and project needs, for consideration in the development of the project scope.

The Region should hold a meeting with the local representatives/residents of the street to introduce the traffic calming policy and assess the need and support for traffic calming on the project. The first meeting should include only those who occupy property along the street within the project area. The Region should request that the locality provide a person or persons to serve as liasons for the local residents within the project area who will be affected by the project, and to communicate information to the public regarding project meeting schedules, etc.

If it is determined at the first meeting that there is a need for traffic calming, and there is local support, a subsequent meeting should be held to review the data collected during the scoping phase and to brainstorm ideas that residents might like the Region to pursue. Notification of the second meeting should go to local government representatives, to residents on the project street and cross-streets, and any affected agencies or organizations.

25.7.1.2 Design Phase I

The Region should develop alternatives after considering the ideas raised at the previous meeting and present them to those invited to the previous meeting. This will enable residents to participate in the development of the alternatives. It is also an opportunity to get ideas from them that may have been overlooked. Provision should also be made to obtain the comments of those who are unable to attend the meeting. When traffic will be diverted as a result of the project, residents and property owners along the streets to be used as alternate routes should be notified of the meeting and the potential impacts to their streets.

The Region should refine the alternatives based on the input/feedback provided by the local citizens and present the refined alternative(s) for consideration and prioritization by the local residents at a follow-up meeting. If necessary, a third Phase I meeting may be held to determine the final traffic management plan to be carried forward.

25.7.1.3 Design Phases II-IV

Development of the traffic calming alternative(s) should be carried out along with the development of other alternatives. Refer to the Design Procedure Manual for a detailed description of the project process.

25.7.2 **Project Approval**

The normal NYSDOT project approval process should be followed. Refer to the Design Procedure Manual.

25.8 MONITORING

All traffic calming projects should be monitored. Studies should be conducted by the Region or the locality both before and after traffic calming measures are implemented. Monitoring is a means of measuring the safety and effectiveness of traffic calming measures in achieving the project objectives, as well as determining the appropriate modifications to be made, if necessary. It will also help improve designs for future projects and determine if corrective treatments are needed. Systematic 'before and after' monitoring is also necessary to evaluate whether the money is well spent.

The safety and effectiveness of traffic calming measures should be evaluated consistent with the traditional techniques used in transportation engineering. A key benefit of monitoring is to provide information which increases the Department's knowledge of good and bad practice in the design and implementation of traffic calming measures. The information can be used to plan and design future traffic calming projects as well as to remove ineffective measures from future consideration. This is especially important due to lack of experience with traffic calming measures in New York State. Collecting the 'before and after' information and sharing it with the Regions will build confidence in the role and performance of traffic calming.

Project monitoring should begin as soon as it is determined, during the project scoping phase, that traffic calming will be considered. Project monitoring should involve gathering 'before' data that supports or negates the concerns of the Department and locality.

When the project is completed and put into operation, the collection of 'after' data should begin. The collection of data should include follow-up meetings with the local residents affected by the project to determine how well the project has responded to their concerns. Photographs of before-and-after geometrics and of the completed features should be included, and used at the meetings. This information is compared to the 'before' data to determine how effective traffic calming is and if it satisfies the project objectives. If any unacceptable impacts are identified, they should be corrected.

The type and extent of monitoring is project specific, however, the following matters should be considered:

- the number and location of monitoring sites (e.g., to detect any diversion of traffic, if one of the project objectives or possible outcomes is a significant reduction in traffic volume),
- the need for a control site (e.g., in relation to overall accident trends),
- whether spot speeds or average speeds through a scheme should be measured,
- the short term and long term effects (does the impact wear off over time?), and
- the number of measurements needed for statistical reliability.

Public reaction to the effectiveness of the installed measures is also a key factor. Monitored results may diverge from the expected effects that were highlighted during project development. Establishing what the public's expectations and perceptions were, and to what extent they have or have not been realized, will be helpful for future schemes. Refer to Section 25.7 for guidance in public involvement activities.

The results of the monitoring should be reported to the Design Quality Assurance Bureau, after which it will be distributed to all Regions for guidance in selecting future traffic calming measures.

The factors monitored should reflect the objectives of the project and be used to assess priorities for funding. They may include accidents and traffic speeds, or traffic flow and diversion to other routes, depending on the particular situation. The guidelines below should assist in determining which parameters can be reasonably measured, and whose measurements can be interpreted to have some direct relationship to the actual traffic calming project.

- 'Before-and-After' Accident Studies to determine annual rates of accidents per million vehicle miles (Acc/MVM) and injuries/MVM) for:
  - all accidents,
  - motor vehicle/bicycle accidents,
  - motor vehicle/pedestrian accidents,
  - transit accidents.

  Perform accident studies to determine how accident trends in the project area have been affected. The length of time of the studies should be sufficient to determine the long-term effects.

- 'Before-and-After' Speed Studies to determine
  - the 85th percentile speed,
  - the 15 km/h (10 mph) pace and per cent of vehicles within it,
  - numbers of priority investigation locations (PILs) and high accident locations (HALs) eliminated.

  The speed studies should be performed upstream of, at, and downstream of the traffic calming feature, to learn its effect on vehicle speeds.

- For urban streets, the percent of vehicles using the facility that attain the speed range for the facility speed category. (See §25.6.1-25.6.4)

- 'Before-and-After' User Volumes to determine
  - the average daily traffic (ADT), vehicles/day,
  - the average annual daily traffic (AADT), vehicles/day,
  - the design hourly volume (DHV), vehicles/hour,
  - the directional design hourly volume (DDHV), vehicles/hour.

Traffic counts should be made on the street where traffic calming will be installed and on the streets to which traffic is expected to divert. The 'after' counts should be made when traffic patterns have stabilized.

- Parking occupancy

- Level of community satisfaction.

25.9 REFERENCES

The following is a list of the publications that were used in the preparation of this chapter.

1. *A Guidebook for Residential Traffic Management*, WA-RD 368.1, Final Report, December 1994, Savage, J.P. Jr., R.D. MacDonald, J.Ewell. Washington State Department of Transportation, Engineering Publications Room SD3, PO Box 47300, Olympia, WA 98504-7300.

2. *Florida Pedestrian Planning and Design Handbook*, May 1996, University of North Carolina, Highway Safety Research Center. Florida Department of Transportation, Safety Office, 605 Suwannee Street, Mail Station 82, Tallahassee, FL 32399-0450.

3. *Highway Design Manual*. Plan Sales Unit, Support Services Bureau, New York State Department of Transportation, 1220 Washington Avenue, Albany, NY, 12232-0204.

4. ITE Traffic Calming Definition, Lockwood, I.M. In *ITE Journal*, Volume 67, Number 7, July 1997. Institute of Transportation Engineers, 525 School Street, SW, Suite 410, Washington, DC, 20024-2729.

5. *Neighborhood Traffic Management and Calming Program*, City of San Buenaventura, Department of Community Services, Engineering Division, 501 Poli Street, Ventura, CA, 93001.

6. Supplementary Pedestrian Crossing Channelization Devices, T.C. Werner memo to Regional Traffic Engineers, July 15, 1997. Transportation Planning, Highway Safety and Traffic Engineering Division, NYS Department of Transportation, 1220 Washington Avenue, Albany, NY, 12232.

7. *Traffic Calming,* July 1995, Hoyle, C.L., Planning Advisory Service Report Number 456. American Planning Association, Publications Office, 122 S. Michigan Avenue, Suite 1600, Chicago, IL, 60603.

8. *Traffic Calming Guidelines*, 1992. Devon County Council, Engineering and Planning Department, Devon County, Great Britain.

9. *The Traffic Calming Program: Simplification and Enhancement of the Neighborhood Traffic Management and Arterial Traffic Calming Programs*, September 30, 1994. City of Portland, Office of Transportation, Bureau of Traffic Management, Neighborhood Traffic Management, 1120 S.W. 5th Avenue, Room 730, Portland, OR, 97204-1914.

25.10 OTHER SOURCES

The publications listed below are additional sources of information related to topics presented in this chapter. Search the Internet Web for up-to-date resources using "traffic + calming" as key words.

1. *Code of Practice for the Installation of Traffic Control Devices in South Australia*, July 1996. Traffic and Operational Standards Section, Department of Transport, P.O. Box 1, Walkerville, South Australia, 5081.

2. *The Florida Roundabout Guide*. Florida Department of Transportation, Maps & Publications Sales, Mail Station 12, 605 Suwannee Street, Tallahassee, Florida, 32399-0450.

3. *Guidelines for the Design and Application of Speed Humps* - A Recommended Practice of the Institute of Transportation Engineers, 1997. Institute of Transportation Engineers, 525 School Street, SW, Suite 410, Washington, DC, 20024-2729.

4. *Manual of Uniform Traffic Control Devices*, 1983. Transportation Planning, Highway Safety, and Traffic Engineering Division, New York State Department of Transportation, 1220 Washington Avenue, Albany, NY, 12232-0204

5. *Modern Roundabout Practice in the United States*, National Cooperative Highway Research Program Synthesis of Highway Practice 264, 1998, Jacquemart, G. Transportation Research Board, National Research Council, 2101 Constitution Avenue, NW, Washington, DC, 20418.

6. *New York State Vehicle & Traffic Law*, (latest edition). New York State Department of Motor Vehicles, Swan Street Building, Empire State Plaza, Albany, NY, 12228.

7. *Roundabout Design Guidelines.* Maryland Department of Transportation, State Highway Administration, P.O. Box 717, Baltimore, MD, 21203-0717.

8. *Traffic Control Systems Handbook*, FHWA-SA-95-032, 1996, Gordon, R.L., R.A. Reiss, H. Haenel, E.R. French, A. Mohaddes, R. Wolcott. Federal Highway Administration, Office of Technology Applications, 400 Seventh Street, SW, Washington, DC, 20590.

9. *Traffic Control Systems Handbook*, Revised Edition, 1985, FHWA-IP-85-11, Wilshire, R., R. Black, R. Grachoske, J. Higanbotham. Federal Highway Administration, Office of Implementation, 400 Seventh Street, SW, Washington, DC, 20590.

APPENDICES

APPENDICES - TRAFFIC CALMING

GENERAL

The guidelines for traffic calming measures included in the appendices are taken from guidelines developed for Washington State Department of Transportation, Florida Department of Transportation, and the City of San Buenaventura, CA. Excerpts from those guidelines are Appendices A, B, and C respectively. They should be used for guidance only until such time as formal guidelines or standards are adopted by the Department.

There has been considerable research and publication of traffic calming materials since the guidelines were published. Interested parties should search the Internet Web for up-to-date resources using "traffic+calming" as keywords.

Refer to Sections 25.9 and 25.10 for bibliographic information on the guideline references and on other sources of traffic calming information.

APPENDIX A

TAKEN FROM

A GUIDEBOOK

FOR

RESIDENTIAL TRAFFIC MANAGEMENT

8/31/98

APPENDIX A

The guidelines contained herein are taken from *A Guidebook for Residential Traffic Management*, prepared for the Washington State Department of Transportation by KJS Associates. They appear with the express permission of KJS Associates. They should be used for guidance only until such time as formal guidelines or standards are adopted by the Department.

There has been considerable research and publication of traffic calming materials since the "*Guidebook*" was published. Interested parties should search the Internet Web for up-to-date resources using "traffic+calming" as keywords.

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16. Abstract

This report provides a comprehensive reference on initiating and running a residential traffic management (RTM) program. Although aimed at smaller cities, towns and counties, the procedures are applicable in any jurisdiction. The Guidebook takes a "toolbox" approach to implementing traffic management projects, with various RTM devices and procedures being the "tools" in each box. Contents include: Introduction — a perspective on controlling traffic in residential areas; A Look at RTM — history, background and worldwide examples of RTM efforts; Getting Started — the first steps to take in starting an RTM program, and using involvement, learning and consensus building tools to build alliances; The RTM Toolboxes — a listing of RTM devices categorized by Speeding, Volume, Accidents and Miscellaneous Toolboxes; Common Design Issues — do's and don'ts for the design and installation of RTM devices; Legal Issues — authority for RTM programs under Washington state and federal statutes, regulations and case law; The Politics of RTM — a realistic look at how to make RTM a political as well as engineering success; and Concluding Thoughts — the author's view of the keys to success for an RTM program.

The Guidebook is illustrated with over 30 photographs of RTM devices in place, plus extensive references for further details.

The Guidebook includes a glossary of RTM terms, an annotated bibliography, a pictorial glossary of RTM devices excerpted from a report prepared by the City of Everett Department of Public Works, and an appendix on "Setting Up a Self-managed RTM Program in a Small Community."

17. Keywords residential traffic management, traffic engineering, traffic calming, neighborhood traffic control, traffic safety, pedestrian safety		18. Distribution Statement This document is available through the WSDOT Northwest Technology Transfer Center. Permission to reproduce parts of this document is granted to all parties in accordance with the "fair use" provisions of the Copyright Act.	
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A Guidebook for

Residential Traffic Management

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Chapter 4.
The RTM Toolboxes

The various traffic management techniques described in this chapter can be thought of as "tools" for "repairing" residential traffic problems. We have grouped these techniques into categories ("toolboxes") to assist users of this guide in their thinking about Residential Traffic Management (RTM). The choice of a specific tool in a given instance depends not only on the nature of the problem, but also upon the character of the neighborhood and the onerousness of the solution (tool). Some tools, if selected without the support of enough local residents along the affected streets, may alienate so many people that the solution is perceived as worse than the problem. Even when a majority agree on a specific remedy, often it's necessary to try out a series of tools before one works to the satisfaction of the majority of interests.

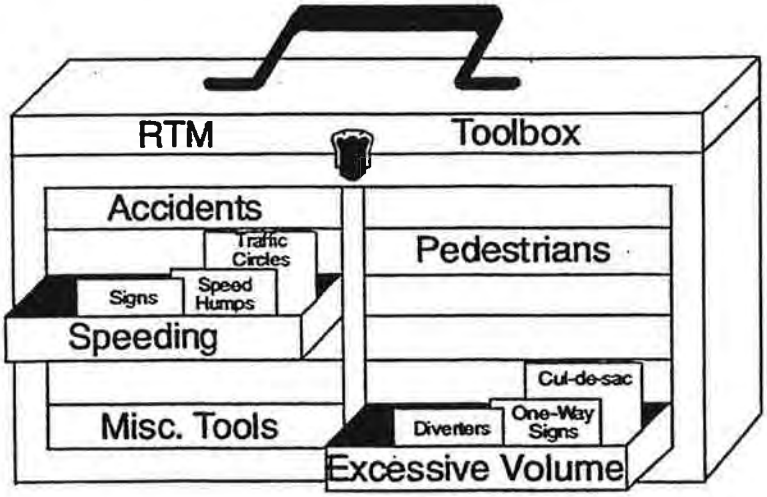


Figure 4-1. The RTM Toolbox Approach

A Catalog of RTM Tools

The research study identified published references to more than 80 individual traffic control devices or measures which have been used for residential traffic management. These devices ranged from speed humps and diagonal diverters to variable-spaced transverse pavement markings and odd speed limit signs (e.g., 16 mph). The reported levels of success and application feasibility varied greatly as well. Table 4-1 lists the principal characteristics of 26 devices or groupings of individual treatments which have been combined for ease of discussion.

The listing of RTM actions in Table 4-1 is divided into Phase I and Phase II categories. The Phase I actions are lower cost and less restrictive than Phase II options, and they can usually be implemented quickly. For example, the City of Bellevue, Washington, reported that 85 percent of their residential traffic complaints can be "solved" (i.e., the complaining neighbors are satisfied with the results) with Phase I responses.

The Toolboxes

In this guide, we have grouped the measures in four toolboxes:

- **Speeding**
- **Volumes**
- **Accidents**
- **Miscellaneous Tools**

Device	Definition	Volume Reduction	Speed Reduction	Change in % trucks	Environment/Pollution Changes in conditions		Safety			Emergency/ Service Vehicle	Dependence on Police	Level of Violation	Type/ Classification of Street			Impact on Adjacent	Use on Bus	Use with Driveways	Use with Curbs &	Construct Cost/	Maintenanc	Aesthetics/ Landscapin	Useful for Spot/Areawide
					Noise	Air	Vehicle Conflicts	Pedestrian	Bicyclist	Access/Delay	Enforcement		Collector Commercial	Local Streets Neighborhood Collector	Local Streets Local Access	Arterial	Route	On Street	Gutters	Problems	Cost/ Proble	Potential	Problems
Bicycle Lanes	Lanes reserved for bicycles	No	No	No	No change	No change	-	-	Improved	No effect	-	Low	Yes	Yes	Yes	No	Yes	Plan with care	-	Low	Low	-	Both
Crosswalks	Painted pedestrian crossing areas mid-block or at intersections	No	No	No	No change	No change	No change	No change	No change	-	-	Low	Yes	Yes	Yes	No	Yes	Yes	Yes	Low	Low	No	Both
Curb Extensions (Entry, Exit, Mid Block)	Extension of the curb into the roadway to create a narrower travel lane to protect parking strip or shorten pedetrian crossing distance	No	Slight	No	Slight Improvement	No change	No effect	Improved	Plan with care	No problems	-	-	Yes	Yes	Yes	No	No	Yes	Yes	Moderate	Low to Moderate	Yes	Both
Diagonal Diverters	Barrier placed diagonally across an intersection to force drivers to make a sharp turn but not allow other movements	Yes	Likely	Yes	Reduction	Improved	Improved	Varies	Varies	Minor Constraint	Self Enforcing	-	No	Avoid	Yes	Yes	Plan with care	Yes	Yes	Low	Moderate	Yes	Usually Areawide
Enforcement (Visible & active police presence)	Extensive traffic enforcement, "emphasis patrols."	Not likely	Yes, temporary	Not likely	Possible reduction	No change	-	Improved	Improved	-	High	Low	Yes	Yes	Yes	Yes	Yes	Yes	-	-	Moderate	-	Both
Forced Turn Islands, Barriers, Channelization	Traffic islands or curbs specifically designed to prevent traffic from executing specific movements at an intersection	Yes	Likely	Yes	Reduction	No change	Improved	Improved	Varies	Minor constraints	-	Low	Yes	Yes	Yes	Yes	No Major Effect	Yes	Yes	Can be complex	Low	Optional, Depends upon priority	Both
Median Barriers	Barrier along the center line of a roadway to prohibit left turns or cross traffic	Yes	No	Possible	reduction	Decrease	Improved	Varies	Varies	Minor constraints	-	Low	Yes	Yes	Yes	No	Possible	Plan with care	Yes	Complex	Varies	Varies	Both
Median Entry/Exit Islands	Traffic islands used to create narrower roadway at entry/exit point	Possible	No	Possible	Possible reduction	Possible Decrease	Improved	Improved	Varies	Minor constraints	-	Low	Yes	Yes	Yes	No	No	Yes	Yes	Low	Varies	Yes	Both
Median Mid Block Islands	Traffic islands between intersections to create a narrower roadway or provide refuge for crossing pedestrians	No	Slight	Slight	No change	No change	Improved	Improved	Varies	Minor constraints	-	Low	Yes	Yes	Yes	No	Possible	Plan with care	Yes	Low	Low	Varies	Both
Mid-Block Slow points, Chicanes	Curbed islands or curb extensions protruding into the roadway, leaving a single-lane or narrow two-lane gap, often at an angle to the centerline	Yes	Yes	Likely	Reduction	Decrease	Improved	Improved	Questionable	Minor constraint	Self Enforcing	-	Yes	Yes	Yes	No	Yes	Avoid near driveways	Yes	Moderate	Moderate to High	Yes	Both
Neighborhood Traffic Safety/Campaign Program Education)	Distribute safety information, special pedestrian safety classes for children	No	Not likely	Not likely	No change	No change	-	Possible Improvement	Possible Improvement	-	-	-	-	-	-	-	-	-	-	-	-	-	Both
Neotraditional Neighborhood Design	Integrated land use and transportation design to increase transit and non-motorized travel to non-residential destinations within the neighborhood	Likely	Likely	Likely	Likely reduction	Unknown	Improved	Improved	Improved	No constraint	-	Low	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Can be high	Varies	High	Area
Novelty signs	"Slow - Nudist Crossing", etc.	No	No	No	No change	No change	No change	No change	No change	-	-	High	No	No	Yes	-	-	-	-	Low	High	No	Spot
Odd speed limit signs	"13 MPH", etc	No	No	No	No change	No change	No change	No change	No change	-	High	High	No	Yes	Yes	-	-	-	-	Low	High	No	Spot
One-Way Entry/Exit Chokers, Half closures, Semi-Diverters	A barrier to traffic in one direction of a street which permits traffic in the opposite direction to pass through	Possible	Yes	Not likely	Reduction	No change	Improved	Improved	Improved	Minor constraint	Initially high	Varies	Avoid	Avoid	Yes	Possible	Plan with care	Yes	Yes	Low	Moderate	Yes	Both
One-Way streets and signs	Restricted entry/exits to/from neighborhoods, one-way street patterns	Yes	Varies	Possible	Reduction	Improved	Improved	Improved	Improved	Plan with care	Low	Low	Yes	Yes	Yes	Yes	Plan with care	Yes	-	Low	Low	-	Usually Areawide
Parking Variants Class I (Zones, Signs, Striping, timed, resident restricted)	Parking areas create narrower roadways and increased activity leading to increased attention by drivers	Possible	Likely	Likely	Possible reduction	No change	Possible Improvement	Possible Improvement	-	No effect	Low	Varies	Yes	Yes	Yes	Yes	Yes	Yes	-	Low	Low	-	Both
Parking Variants, Class II Shifting Traveled Way)	Alternating parking from one side of street to the other, parallel or diagonal	Possible	Likely	Not likely	Possible reduction	No change	Increased conflicts	Possible Improvement	Varies	No effect	-	-	Yes	Yes	Yes	No	No	Yes	Yes	Low	Low	Yes	Spot

Table 4-1. A Catalog of RTM Actions

Device	Definition	Volume Reduction	Speed Reduction	Change in % trucks	Environment/Pollution Changes in conditions		Safety			Emergency/ Service Vehicle Access/Delay	Dependence on Police Enforcement	Level of Violation	Type/ Classification of Street			Impact on Adjacent Arterial	Use on Bus Route	Use with Driveways On Street	Use with Curbs & Gutters	Construct Cost/ Problems	Maintenanc Cost/ Proble	Aesthetics/ Landscapin Potential	Useful for Spot/Areawide Problems
					Noise	Air	Vehicle Conflicts	Pedestrian	Bicyclist				Collector Commercial	Local Streets Neighborhood Collector	Local Streets Local Access								
Pavement Treatment, Class II (Texture/Composition, Patterns, Color)	Special pavement compositions and markings to alert drivers of special conditions	Not likely	Possible	Possible	Possible reduction	No change	-	Possible improvement	Varies	No constraint	-	-	Yes	Yes	Yes	No	Yes	Yes	-	Low	Low	-	Both
Pavement Treatments, Class I Marking and Striping & Color	Special pavement markings at entries, hazard locations or crosswalks to alert drivers of special conditions	No	Possible	Not likely	No change	No change	-	Possible improvement	-	No effect	-	-	Yes	Yes	Yes	No	Yes	Yes	-	Low	Low	Yes	Both
Raised Crosswalks	Crosswalks raised transversely across the pavement	Possible	Yes	Not likely	No change	No change	-	Improved	Plan with care	Minor constraint	Self Enforcing	-	Plan with care	Yes	Yes	Yes	Plan with care	Yes	Yes	Moderate	Low to Moderate	Yes	Site
Speed Alert w/Warning	Residents use radar to clock speeds, record license plate numbers, police send notice to drivers	No	Varies	Not likely	Slight, temporary, reduction	No change	-	Slight, temporary, improvement	No change	-	High	-	Yes	Yes	Yes	No	Yes	Yes	-	-	Low	-	Both
Speed Bumps (about 3.5"h X 6")	Short strips of raised pavement, avoid using on public streets	Possible	Varies	Yes	Increased noise	Increase	Safety problem	Improved	Plan with care	Significant problems	Self Enforcing	-	No	No	No	-	No	-	-	Low	High	-	Spot
Speed Humps (about 2.75-4"h X 12)	Raised sections of pavement across the traveled way with curved transitions	Possible	Yes	Possible	No change	No change	-	Improved	Plan with care	Minor constraint	Self Enforcing	-	Plan with care	Yes	Yes	Yes	Yes	Yes	Yes	Low	Low to Moderate	Yes	Both
Speed limit signs	"25 MPH in residential areas", etc	No	No	No	No change	No change	No change	No change	No change	-	High	High	Yes	Yes	Yes	No	-	-	-	Low	Low	No	Both
Speed Tables (3-4"h X 22)	Speed humps with a long flat section, often used as crosswalks	Possible	Yes	Possible	No change	No change	-	Improved	Plan with care	Minor constraint	Self Enforcing	-	Plan with care	Yes	Yes	Yes	Plan with care	Yes	Yes	Moderate	Low to Moderate	Yes	Both
Speed Watch	Illuminated display shows actual speed to passing drivers	No	Varies	Not likely	Slight, temporary, reduction	No change	-	Slight, temporary, Improvement	No change	-	None	-	Yes	Yes	Yes	No	Yes	Yes	-	-	Low	-	Spot
Stop Signs	Stop signs, two way or four way, used to assign right-of-way at intersections.	Seldom	Varies	Not likely	Increased noise	Increase	Varies	Varies	Varies	No constraint	Low	Varies	Follow MUTCD guidelines	MUTCD guidelines	MUTCD guidelines	No	Yes	Yes	-	Low	Low	-	Both
Street Closures, Cul-De-Sacs	A complete barricade of a street at an intersection or a dead end street	Yes	Yes	Yes	Reduction	Improved	No	Improved	Improved	Significant constraints	-	-	No	No	Yes	Yes	No	Yes	-	Moderate	Moderate to High	Yes	Both
Traffic Circles	These geometric design features force traffic at intersections into circular maneuvers	Possible	Yes, near circle	Yes	No change	No change	Improved	Varies	Varies	Minor Constraint	Self Enforcing	-	Plan with care	Yes	Yes	Yes	Plan with care	Yes	Yes	Low	Moderate	Yes	Both
Traffic signals	Vehicle or pedestrian actuated	No	Possible	No	Increase	Increase	Improved	Improved	Improved	-	-	Low	Yes	Avoid	No	No	-	-	-	Moderate	Low	No	Both
Truck prohibitions	"No trucks over 10,000 lbs ", etc.	Minor	No	Yes	Likely reduction	Slightly improved	Improved	Improved	Improved	-	-	Low	No	Yes	Yes	Yes	-	-	-	Low	Low	No	Area
Turn Prohibition sign	Regulatory signs at intersections	Yes	Likely	Possible	Reduction	No change	Improved	Varies	Varies	No effect	Low	Varies	Yes	Yes	Yes	Yes	Yes	Yes	-	Low	Low	-	Both
Woonerf	Traffic calmed residential area where the street is an extension of the front yards and vehicles share street space with bikes and pedestrians	Yes	Yes	Yes	Significant reduction	Improved due to lower vol.	Improved	Improved	Improved	No constraint	-	Low	No	No	Yes	No	No	Yes	Yes	High	Varies	High	Spot

Table 4-1. A Catalog of RTM Actions

Each toolbox contains the actions most appropriate to address a specific problem, i.e., speeding traffic, high volumes in residential areas and high accident experience at a residential intersections, plus a "catch-all" for other ideas appropriate for special situations. Overlap among the tool boxes cannot be avoided, but this initial sorting can allow the user to first examine what has worked best in similar situations for his or her particular problem.

The tools have been arranged in a particular order. Common sense suggests that we start with the least onerous, often lowest cost solution first; then move to more restrictive ones as needed. However, frequently the first choice is enough to "solve" the problem; "solve" in the sense that residents benefit sufficiently from lower speeds, less noise, fewer cut-through drivers, etc. to stop complaining. Experience shows that these less onerous, but effective solutions can be used as tests, or thresholds, before the more expensive measures are employed. Further, in a number of cities with effective programs, these initial measures are bundled together to form a package of solutions that comprise Phase I (or year one) of a two-phased program. The more restrictive physical devices, e.g., speed humps, traffic circles, diverters, are normally used in the second phase after a lack of success has been demonstrated with the Phase I measures.

The following sections describe each toolbox and, separately, the tools themselves. The discussion about the toolboxes provides an overall approach to dealing with the various problem situations which arise in residential neighborhoods.

The effectiveness of these tools will vary from one instance to the next. For example, a 25 mph speed limit sign placed on a long, wide, downhill, straight street with few parked cars is probably not going to induce many drivers to drive at or below 25 mph. An *average speed* of 35 mph would not be uncommon on such a street. Often, 10 to 15 percent of the motorists will be going down the hill at more than 40 mph. We could even argue that the street was designed to induce speeds in excess of the 25 mph limit; certainly the effect of the design in this situation is undesired speeding.

In addition to speed limit signs, our Phase I speeding toolbox lists other eight potential actions. A "Speed Alert" or "Speed Watch" program is usually the first step in most jurisdictions for dealing with confirmed speeding problems on local streets. A major benefit to the Speed Watch action is that it directly involves local residents in gathering data on who the speeders really are. More often than not, the speeding drivers turn out to be their own neighbors, not just "outsiders" cutting through the neighborhood on their way to or from work. Documenting who is causing the problem can help achieve the desired result through peer pressure in some cases.

Stop signs are the most-often requested traffic control device in residential areas. Although the basic purpose of a stop sign is to assign right-of-way at an intersection, residents often believe that the installation of stop signs, or a series of stop signs, at previously uncontrolled intersections will reduce speeds and volumes of cut-through traffic. Unfortunately, experience has shown that this is not usually true[1]. A

The Speeding Problem Toolbox

Speeding is such a common problem that we will use it to illustrate in detail how the toolboxes are used in the RTM program. As shown in Table 4-2, the "Speeding" tool box contains measures of increasing severity or traffic restraint. They are also arranged in phases to separate those measures that can be implemented quickly at little expense from those actions which require more planning and a longer lead time.

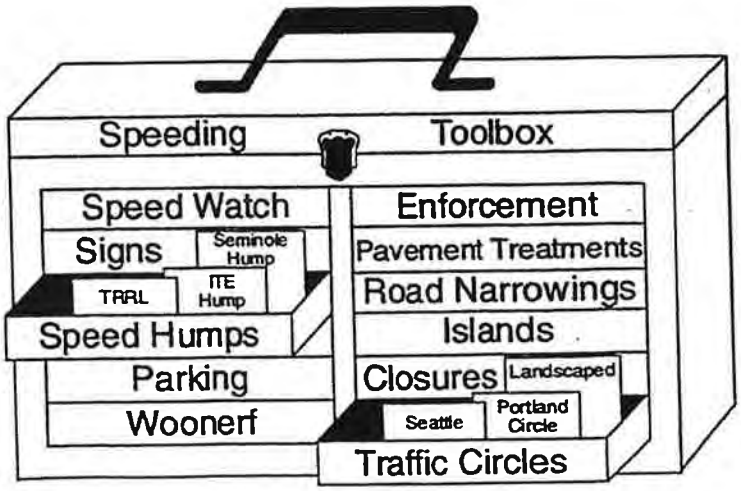


Figure 4-2. The Speeding Toolbox

Table 4-2
Speeding Tool Box
By Program Phase

Phase I Toolbox	Phase - II Toolbox (When Phase I Measures Fail)	
	Intersections & Entry Ways	Along the Street/Street Section
Warning, Caution Signs	Pavement pattern, texture, color variations (e.g. Cobblestone street section pseudo humps etc.)	Landscaping: foliated trees in planted strip, curb extensions, median islands. (shortens width, depth of view)
Speed limit, zone signs	Landscaping: foliated trees in circles, curb extensions, islands (Shortens width, depth of view)	Parking variants e.g. add parking, change parallel to diagonal, perpendicular, staggered, alternating
Pavement striping, marking, coloring	Raised street surface, e.g. Speed tables, thresholds of minor street	Curb extensions that don't alter number or width of lanes, e.g. protected parking
Rumble Strips	Chokers (half closures), using curb extensions to reduce turn/curb radii, lane width/number/access/egress	Median islands (lengths vary, may serve as turn barriers)
Speed Alert, (large, illuminated, roadside speed display in driver's view; shows driver's actual speed)	Traffic circles, rotaries, round-a-bouts	Raised Crosswalks
Police visibly present (enforcement)	Median islands, barriers, turn channeling	Speed humps,undulations, dips; speed tables/platforms
Speed watch/warning. Residents use radar, record license plate # of speeders, police send letter to alert/warn vehicle owners of observed vehicle speed, request compliance.	Diagonal diverters	Slow Points. Chokers, curb extensions that reduce number and or (less effectively) width of lanes; includes chicanes; are typically one lane two-way (Slow points may also be two lane two-way.)
Photo Radar. Police offsite, automatically issue tickets to owners of speeding vehicles. Photos contain pictures of license plate and occupants of the car.	Street closure	

more thorough discussion about using stop signs in an RTM program is presented in the section on "Paint, Buttons and Signs" later in this chapter.

The City of Portland, OR, developed a systematic approach for installing stop signs at uncontrolled intersections within a residential neighborhood. The Neighborhood Stop Plan[2] may be implemented on local access streets arranged in a grid pattern. Using a "Denver stop pattern," this application of stop signs establishes a pattern of stopping traffic on every other block throughout the entire neighborhood. Since there are no "through" streets in this pattern, it encourages an even distribution of traffic within the neighborhood. However, this program is not intended to reduce speeds or volumes, but rather to establish a rational traffic control plan in a residential area with grid streets.

Police enforcement is an effective short-term tool, but few police departments have the resources to respond to every neighborhood's complaint about speeding traffic. In addition, research has shown that speeds quickly creep back up once the police leave.

Photo radar is likely to be very effective at speed control, but it is equally controversial. Its use is not yet legally permissible in many states or local jurisdictions; although it has been used in some states on a trial basis, its legality has not been tested in the higher state courts. With photo radar, cameras are carefully positioned to take pictures of both drivers and license plate numbers of only those vehicles that are speeding. Film and data result in automatically issued tickets. Over time, selective use of photo radar might provide a very widespread and positive impact on driver behavior on residential streets. But, along with the many effective physical devices in the phase II speeding toolbox, it probably won't be used very long unless a majority of residents condone its.

More Restrictive Measures

If the actions in Phase I fail to abate speeds on the problem street(s), more restrictive measures may be applied.

In speed control, there is one primary rule: If you force the driver to make a significant side-to-side or up-and-

Figure 4-3. Speed reader board

Figure 4-4. A speed hump in action

down movement (lateral or vertical shift), almost everyone slows down. A second, though not so sure, rule is: If the width of the view ahead is narrowed, such as by foliated trees near the roadway, an actual narrowing of the lane widths (to 10 feet or less) or by buildings next to the sidewalk (i.e., buildings sited with little or no setbacks), a slowing effect may be realized.

The Australian Road Authorities sum up their experience by:

> Maximum vehicle speeds can only be reduced by deviation of the traveled path. Speed reduction can be achieved using devices which shift vehicle paths laterally (slow points, roundabouts, corners) or vertically (humps, platform intersections, platform pedestrian/school/bicycle crossings). Speed reduction can be helped by creating a visual environment conducive to lower speeds. This can be achieved by "segmenting" streets into relatively short lengths using street scapes or changes in alignment to create short sight lines. Pavement narrowing has only minor effects on average speeds, and usually little or no effect on maximum speeds.[3]

The Phase II portion of our speeding toolbox concentrates on actions which follow the above philosophy. Table 4-2 list actions which can be used at either intersections and entry ways, or along sections of the residential street. Physical devices such as speed humps, raised intersections, and "slow points" such as chokers or curb extensions to narrow the roadway, are the most successful means of controlling speeds on existing streets.

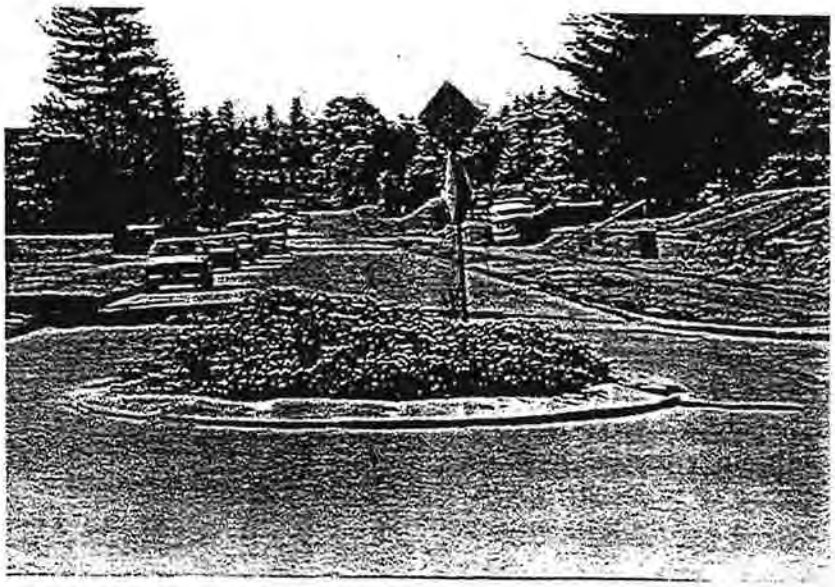
Pavement variations, parking variants and landscaping can be effective design tools for new or redeveloped streets. But they are not very useful by themselves in a retro-fit situation.

Traffic circles have found wide application in the Pacific Northwest to reduce travel speeds through neighborhoods. Portland Oregon, and Seattle, Washington have used circles extensively throughout their residential neighborhoods to control both speeds and accidents with good success.

Properly designed and installed speed humps are very effective in reducing speeds. Homburger *et al* report 85th-percentile speed reductions of 14 to 20 mph at the hump itself, and "substantial reductions" between devices.[4] Nicodemus reported a reduction in speeds above 30 mph from 34% before the hump was installed to only 8% after installation.[5] A study of 17 "road hump" installations in England found an average speed reduction of 11 mph.[6]

Research has shown that the application of several RTM tools in concert with one another provides the greatest benefit to speed control. Typical combinations include:

- a series of three speed humps spaced about 300 feet apart with advance warning signs and bold diagonal striping;
- speed tables (i.e., raised intersection areas) at key intersections with raised crosswalks between intersections; and
- narrow entryways with special pavement treatments and signing to signify residential areas, supplemented by lane narrowing and repeated pavement treatments throughout the neighborhood.



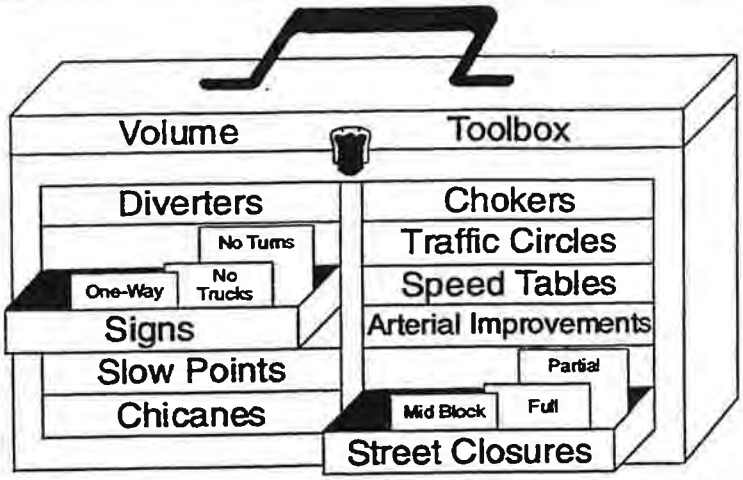


Figure 4-5. The Volume Toolbox

The Volume Problem Toolbox

Many residents complain about too much traffic on their local street. Some jurisdictions, such as the City of Seattle, have a policy of managing traffic in place to reduce speeds and accidents, but do not try and force drivers to use other routes. The reasoning behind this approach is that diverting traffic from one residential street simply shifts the problem elsewhere, and creates new adverse impacts in someone-else's neighborhood.

Cut-through traffic in residential areas often results from congestion on the nearby arterial streets. Drivers forced to wait through several signal cycles at major intersections try to avoid the bottlenecks by using local streets to avoid key intersections. As noted previously, the most effective actions in this case may be to improve traffic conditions on the arterials and attract drivers back to the through street.

The RTM alternative is to increase travel times through the residential neighborhoods, or preclude them altogether in radical cases. The tools listed in Table 4-3 can be highly effective in diverting cut-through traffic, but at the cost of inconvenience to residents as well. Many of the Phase I actions are the same as those in the Speeding Toolbox, because driving times are only shorter through the neighborhood if the drivers travel at 35 or 40 mph. These measures are only marginally effective, however, and would likely only result in a shift in traffic when viable alternative routes are available.

At some locations, a simple turn prohibition supplemented by strict enforcement or a physical barrier, can result in a major shift in traffic. The City of Bellevue, WA, reduced volumes on a section of 108th Avenue NE south of the central business district by prohibiting the southbound through movement at one key intersection and frequent, strict enforcement of the 25 mph speed limit.

One way streets have been applied in cut-through situations to restrict access into or out of a neighborhood at key points. Stop signs have not been included in Table 4-3 because although they can add travel time to a motorists trip, they are not effective in reducing volumes in most cases. (See also the discussion about stop signs under the Speeding Toolbox section above and the "Paint, Buttons and Signs" section below.)

Special treatments on the entryways into residential neighborhoods can be effective in communicating to the driver that he or she is entering a residential area. Narrowed lanes at the entry combined with special

Figure 4-6. Diagonal diverter

Table 4-3
Volume/Cut-Through Traffic Tool Box
By Program Phase

Phase I Toolbox	Phase - II Toolbox (When Phase I Measures Fail)	
	Intersections & Entry Ways	Along the Street/Street Section
No Through Traffic signs (Traffic volume reduction is possible only if alternate routes exist)		Parking variants e.g. add parking, change parallel to diagonal, perpendicular, staggered, alternating
One-way Signs (Caution: May also increase cut-through volumes and speeding)	Chokers (half closures), using curb extensions to reduce turn/curb radii, lane width/number/access/egress	Speed humps, undulations, dips; speed tables/platforms
Speed watch/warning (effective only if cut-through time savings are related to excessive travel speeds)	Traffic circles, rotaries, round-a-bouts	Slow Points. Chokers, curb extensions
Police visibly present (enforcement)	Diagonal diverters	
Photo Radar. Police offsite, automatically issue tickets to owners of speeding vehicles. Photos contain pictures of license plate and occupants of the car.	Forced turn channelization	Median Barriers
Turn Prohibition Signs	Full Street Closure, Cul-De-Sacs	

pavement treatments of color or texture and landscaping convey the residential nature of the street and help discourage through traffic. These can be very effective if repeated at key locations such as mid-block crosswalks throughout the neighborhood.

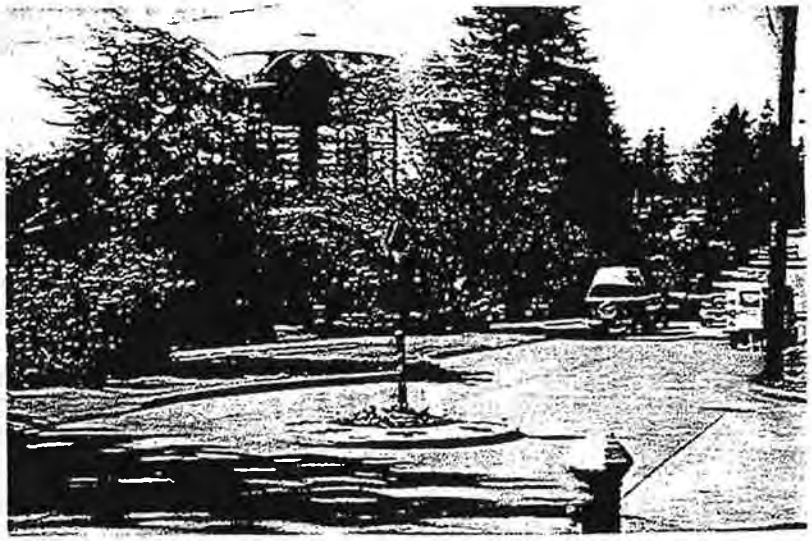


Figure 4-8. Traffic circle (minimal type design)

Diverters

Physical measures to stop selected traffic movements are the best way to deal with unwanted traffic volumes and cut-through traffic. These include street closures (e.g., cul-de-sacs), half-closures to allow only one direction of travel into or out of a given approach at an intersection, or diagonal diverters at intersections which allow left or right turns, but prohibit through movements.

Street closures and diverters create problems for emergency services vehicles because they restrict access. Such measures should be implemented only after a thorough analysis of their benefits and impacts.

The Accident Problem Toolbox

Accidents are not usually a significant problem in residential areas. Most jurisdictions keep good accident records and take remedial actions in a timely manner through their normal traffic engineering processes. The Accident Toolbox, shown in Table 4-4, includes a limited number of RTM actions which may reduce accident rates at residential intersections. In addition, an extensive application of RTM measures in neighborhoods can result in significant reductions in accidents on local access streets.[7]

Often, as indicated under Phase I, the installation of stop or yield signs at key intersections to delineate the primary through movement can reduce right-angled accidents significantly. As noted in the Speeding Toolbox section, the City of Seattle has experienced good success with traffic circles in reducing accident rates in residential areas.

Stop signs, included in Table 4-4 as a possible Phase I measure, are usually an anathema to traffic engineers in residential neighborhoods. Few residential intersections meet current *MUTCD* warrants for stop signs.[8] However, a recent article by LaPlante and Kropidlowski[9] indicated considerable success in reducing accidents with four-way and two-way stops on residential streets in Chicago. Their study of 50 intersections between 1982 and 1988 found a 69 percent reduction in accident rates after stop signs were installed at previously uncontrolled intersections. Yield signs may also be appropriate in certain

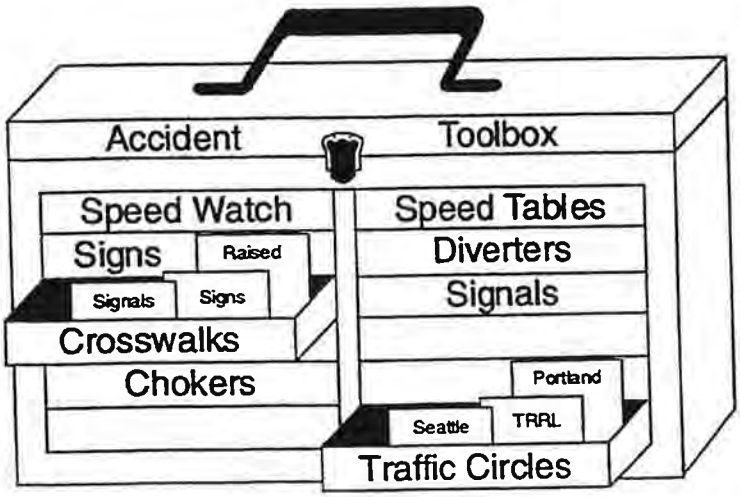


Figure 4-7. The Accident Toolbox

Table 4-4
Accident Problem Tool Box
By Program Phase

Phase I Toolbox	Phase - II Toolbox (When Phase I Measures Fail)	
	Intersections & Entry Ways	Along the Street/Street Section
Speed limit, zone signs	Raised street surface, e.g. Speed tables, thresholds of minor street	Raised and landscaped crosswalks for pedestrian accidents)
Speed watch/warning. Residents use radar, record license plate # of speeders, police send letter to alert/warn vehicle owners of observed vehicle speed, request compliance	Chokers (half closures), using curb extensions to reduce turn/curb radii, lane width/number/access/egress	Speed humps, bumps, undulations, dips; speed tables/platforms (effective where accidents are speed related)
Police visibly present (enforcement)	Traffic circles, rotaries, round-a-bouts	Slow Points. Chokers, curb extensions
Warning signs	Diagonal diverters	
Stop signs	Forced turn channelization	Median Barriers
Yield signs	Full Street Closure, Cul-De-Sacs	
Turn Prohibition Signs	Flashing beacons	

Table 4-4. RTM Accident Tools

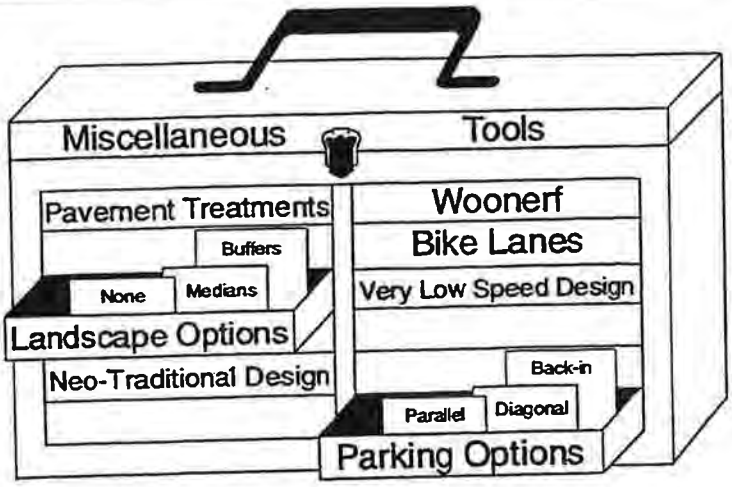


Figure 4-9. The Miscellaneous Toolbox

situations. In short, stop or yield signs may be the best device, and they should not be discarded out of hand.

Obviously, many accidents in residential areas are the direct result of excessive speed by drivers. Thus, all of the actions in the Speeding Toolbox may be applicable in a given accident situation.

Standard traffic engineering measures such as warning signs, proper illumination and pavement markings can be applied at high accident locations in residential areas. Sidewalks, paved shoulders and bike lanes can be used to provide separate traveled ways for pedestrians and bicyclists. The jurisdiction should be careful to maintain the low-speed residential character of the street, and not make it look like an arterial to the driver. The residential street should be made to look and feel as if it is shared transportation space (among residents, pedestrians, bicyclists and motor vehicles), not the exclusive domain of the motor vehicle.

At more serious accident locations, a site-specific study should be made to determine the causes of repeated accidents. At limited sight distance locations, advance warning signs or channelization may be needed even on low volume residential streets.

Miscellaneous Tools

The measures listed in Table 4-5 are mainly design techniques for residential streets rather than specific devices. The woonerf and neo-traditional street design concepts are described briefly in Chapter 1, and several references are listed for further research.[10]

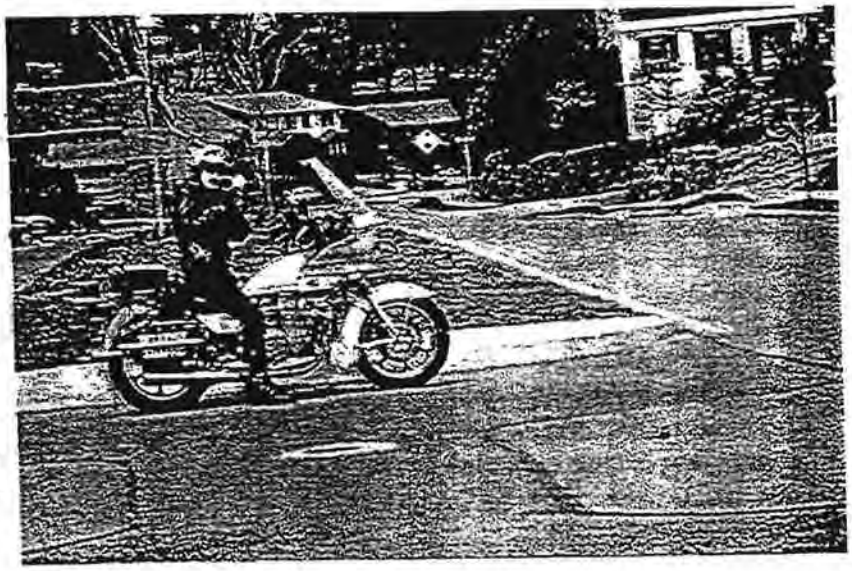
Landscaping is also discussed below, but should be used only as a supplement to other RTM measures such as chokers or entry treatments; landscaping is not a stand-alone measure.

Operational Measures

The following Phase I measures are largely operational, but they can be effective in many instances.

Speed Watch and its variations

Speed Watch is a public awareness program to observe and record vehicle speeds on residential streets, and to notify the owners of these vehicles when and where they were observed speeding. In many jurisdictions it is the first measure when complaints are received about speeding traffic on residential streets because: (1) it gets the neighbors involved in the solution, and (2) it provides valuable data on the severity of the problem.



Miscellaneous Measures	
Pavement treatments	Landscaping
Woonerf	Parking variants such as diagonal parking, back-in only parking
Low-speed design	Bike lanes
Neo-traditional street design	Sidewalks or paved shoulders

Table 4-5. RTM Miscellaneous Tools

Citizen volunteers are trained by city staff in the operation of a radar gun, and a suitable site is selected. Volunteers work in two-person shifts: one operates the radar unit while the other records the vehicle information (time, speed, license number and description) for all vehicles during a set time period. The jurisdiction takes the information and sends letters to the registered owners of all speeders. A cross-check is made before the letters are sent to make sure the license number matches the description of the vehicle.

A variation on this theme is the use of an unmanned radar unit with a reader board to display the speed of the approaching vehicle. It reminds drivers of their travel speed and reinforces their attention to slower speeds in residential areas.

Coupled with frequent police enforcement, this approach can be effective in neighborhoods with speeding problems on one or two through streets.

Enforcement

In specific instances, frequent police monitoring and enforcement of speed limits in residential areas can be effective. Particularly along commuter routes, the constant expectation of enforcement can reduce the travel speeds of frequent users of the street.

However, the limited resources of most police departments makes this option unattractive due to the inherently low-volume nature of the streets in question.

System Operations (one-way streets, etc.)

Some jurisdictions have implemented one-way streets or one-way entry or exit points for residential neighborhoods to reduce cut-through traffic. The degree of success varies with each location.

Two proto-typical one-way street systems for residential areas have been used in RTM programs. Both concepts have proved highly effective in eliminating cut-through traffic. The "one-way maze" concept forces drivers to take circuitous paths through the neighborhood, and the "limited entrance" scheme reduces the number of opportunities for penetrating the neighborhood.

One-way streets also inconvenience local residents and may impede emergency vehicle access. Therefore, their use should probably be limited to extreme situations where cutting through the neighborhood represents a significant time or distance advantage over the arterial routes.

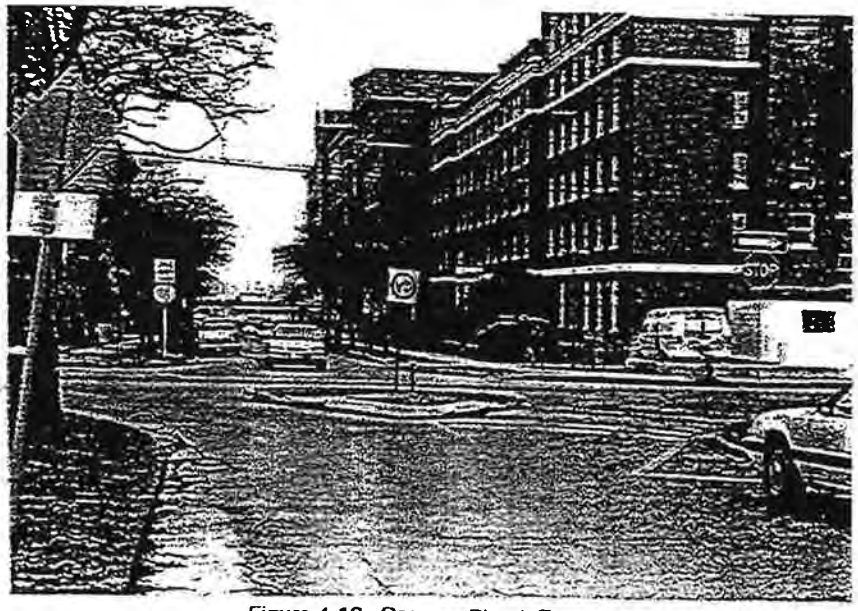


Figure 4-10. One-way Street Example

Paint, Buttons and Signs

This section discusses the traditional and innovative uses of paint, buttons and signs as RTM measures. Innovative applications include variable-width paint stripes (i.e., changing spacing and width to give drivers the illusion of speed), lane delineation with buttons (narrowing lane widths to encourage slower speeds), rumble strips between the traffic lane and ped/bike lane, and stop signs at low volume intersections.

Stop Signs

When traffic problems become noticeable in neighborhoods, stop signs are often the first measure requested by local residents to slow speeders or reduce cut-through traffic. However, numerous studies have indicated that stop signs are **not** effective devices to reduce either speeds or volumes.[11] Typical are the results obtained in a study of two-way stop sign installations at nine residential intersections in Portland, OR.[12] Before-and-after speed studies on all 36 legs of these intersections found that the 85th-percentile speeds remained the same on 19 legs (53%), increased by 2 mph or more on 4 legs (11%) and decreased by 2 mph or more on 13 legs (36%).

Portland, OR's, program to install stop signs on an alternating block basis in neighborhoods with a grid street pattern is an innovative approach to controlling traffic in residential areas. (See discussion under the "Speeding Toolbox" section above.)

Stop signs are traffic control devices used to assign the right-of-way at intersections with significant traffic volumes or accidents. The *MUTCD* lists warrants for stop signs that discourage their use on low volume residential streets, except in cases of "high speed, restricted view (or) serious accident record."

As mentioned before, LaPlante and Kropidlowski[13], found that stop signs in residential areas can have a beneficial safety effect. Their study found a 69 percent reduction in accident rates after stop signs were installed at unsigned intersections.

Therefore, stop signs should be considered as a safety measure on residential streets in urban areas, but should not be used to control speeds or volumes.

Yield Signs

Yield signs also assign right-of-way at intersections, but without requiring drivers to come to a complete stop. Like stop signs, yield signs should be used to address an identified traffic safety problem in a residential area and not for speed or volume control.

Speed Limit Signs and Restrictive Speed Zoning

European studies have shown significant beneficial effects on traffic speeds and pedestrian-related accidents in residential areas with very low speed limits of 15 to 30 km/hr (about 10 to 20 mph)[14]. When these areas are supported by physical RTM measures such as speed humps, traffic circles and roadway narrowings, speed reductions of 20 to 40 percent were observed. However, consistent with American experience, speed limit signing alone resulted in no measurable reductions in average or 85th-percentile speeds.[15]

Thus, it appears that speed limit signs alone will do little to reduce speeds in residential areas.

Figure 4-11. Multi-way stop on low volume residential street

Turn Prohibitions

The installation of "No Right Turn" or "No Left Turn" signs at key entry points to the neighborhood can significantly reduce cut-through traffic. However, their degree of success is directly related to strict and frequent enforcement. At problem locations, the signs should be augmented by channelization to discourage or prohibit these movements.

Pavement Markings

The City of Phoenix, Arizona, has experimented with variable-spaced, variable-width pavement markings in conjunction with speed humps. Their studies indicate a significant reduction in speeds over low humps when the pavement is marked with diagonal stripes that become narrower and more closely spaced as the driver approaches the speed hump. The spacing changes make it appear that the driver is approaching them faster than he or she actually is traveling, thus reinforcing the need to slow down.

Physical Control Devices

This section contains descriptions of some of the commonly used neighborhood traffic control devices. This list is not all inclusive. Other devices are available and may also be considered.

Temporary Installations

Many neighborhood traffic devices can be installed on a temporary basis by using traffic barricades, cones, traffic barrels, and pre-cast traffic barriers. Use the same engineering standard of care as with a permanent installation. Proper signing, channelization, and illumination by street lights or flashing construction warning lights are just as important for temporary installations as with permanent ones. The aesthetics of temporary devices are also important since they will affect the residents' and drivers' perceptions of a permanent device. Figure 4-13 shows a good example of a temporary installation. Residents may be shown illustrations of permanent RTM devices to offset any potentially adverse reactions to the temporary installation.

Figure 4-12. 15 Km/H Speed Limit

By installing temporary devices, public reaction can be obtained, traffic patterns reviewed, and changes made before significant amounts of money are spent on permanent revisions. Some cities have installed temporary measures only to discover that the solution was worse than the original problem. Modifying or removing a temporary device is much less expensive (and less embarrassing) than changing a permanent device.

When temporary devices are installed, emergency services personnel should drive through the area with

Figure 4-13. A temporary installation of a street closure

their vehicles and test their ability to navigate the obstacles. Based on their suggestions, be prepared to experiment with revisions to improve the permanent installation.

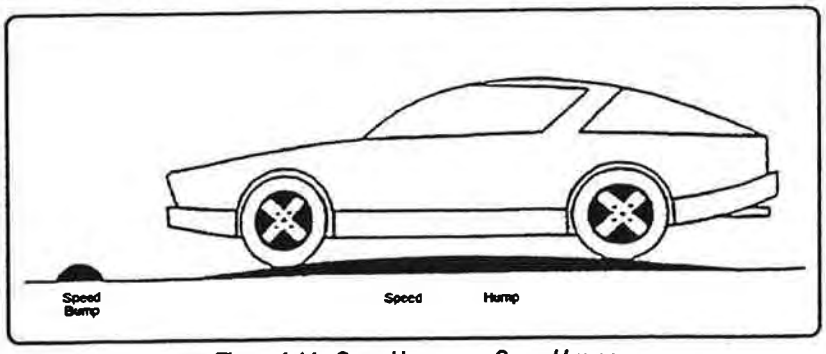


Figure 4-14. Speed hump vs. Speed bump

Speed Humps

A speed hump is differentiated from a speed bump as shown in Figure 4-14, although speed humps are signed as "speed bumps" in some jurisdictions. Speed humps normally have a maximum height of 3 to 4 inches with a travel length of about 12 feet. Speed bumps, commonly used in parking lots and on some private roadways are generally from 3 to 6 inches in height with a length of 1 to 3 feet. **Speed bumps should never be used on public roadways.**

From an operational standpoint, humps and bumps have critically different impacts on vehicles. Within typical residential speed ranges humps create a gentle vehicle rocking motion that causes some drive discomfort and results in most vehicles slowing to near 15 miles per hour at the hump and 20 to 25 miles per hour between property spaced humps in a system. At high speeds a hump acts as a bump and jolts the vehicle suspension and its occupants or cargo.

Numerous designs have been developed for speed humps, and they are the most common RTM device in place today throughout the world.[16] Seminole County, Florida, developed its own speed hump profile and has had good success with its application.[17] Illustrated in Figure 4-15, this profile consists of a segment of a circle with an approximate 72-foot radius, followed by a 3-inch high, ten foot long plateau, followed by a similar radius on the downstream end.

The Institute of Transportation Engineers has recommended a parabolic speed hump design which is based on a profile developed by the Transport and Road Research Laboratory (TRRL) in Great Britain. Shown in the top half of Figure 4-16, this TRRL design produces vehicle speeds near 15 mph at the hump and 20 to 25 mph between properly spaced humps. For contrast, the Australian flat-topped design is shown in the bottom half of this figure.

A recent Recommended Practice of the Institute of Transportation Engineers[18] incorporated the parabolic shape of the TRRL road hump design as its recommended standard for speed humps.

The City of Portland, Oregon, modified this design for use on arterial streets by changing the circular sections to smoother parabolic ones. The Portland design is illustrated in Figure 4-17.

There are no generally accepted standards for signing and marking speed humps. Advance warning signs should be installed upstream of speed humps (100 feet desirable). Figure 4-18 shows a typical signing and striping plan from the City of Bellevue, WA. The

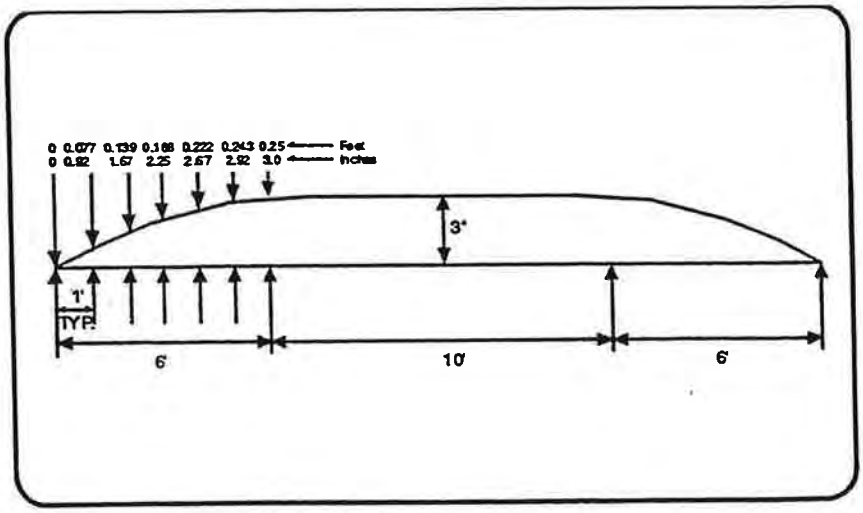


Figure 4-15. The Seminole hump

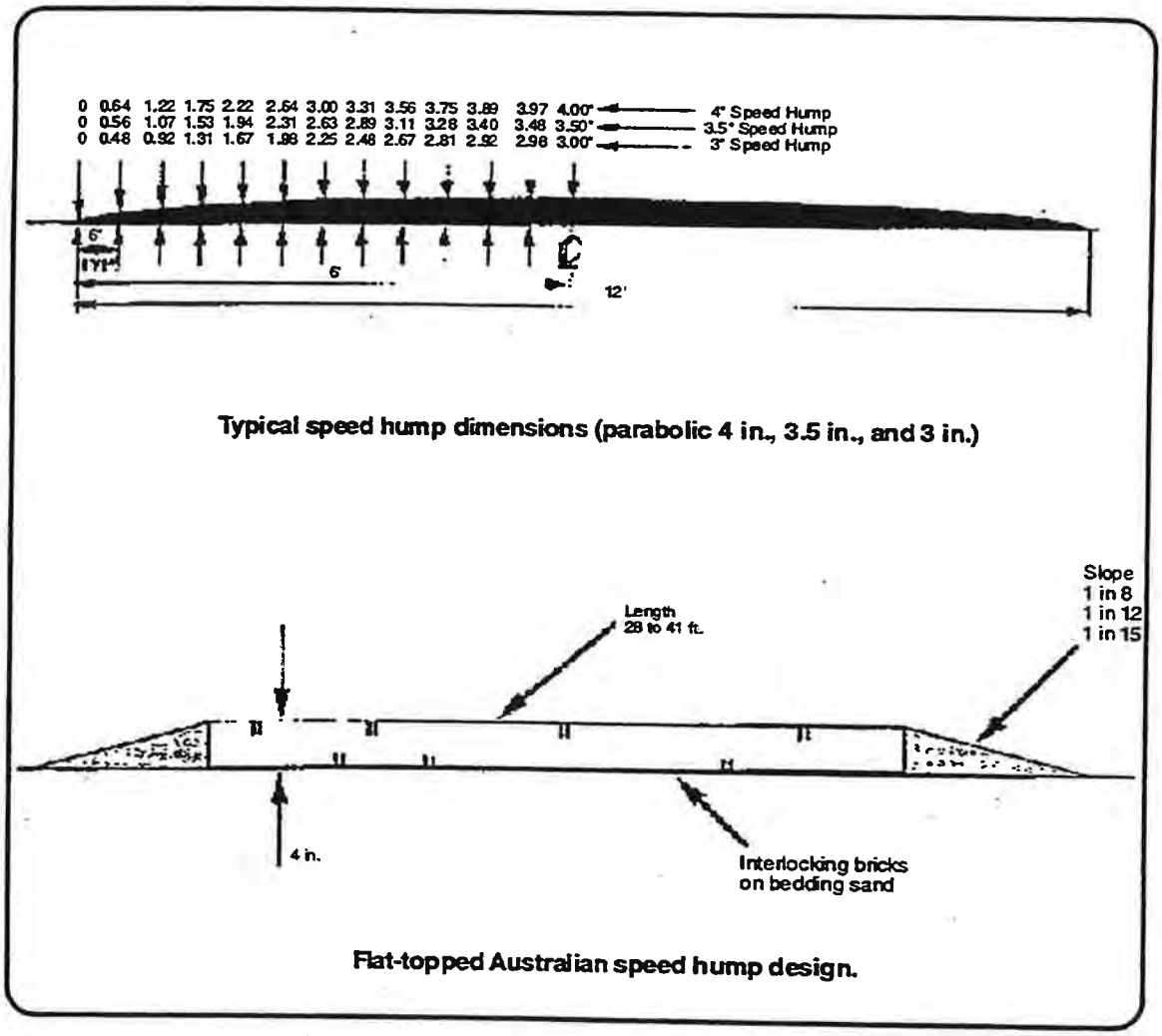


Figure 4-16. The TRRL and Australian road hump design

hump itself should have adequate pavement markings with reflectors or reflective paints so that drivers can clearly see the hump on a dark rainy night.

Repeated experience has shown that several humps in a row along a street are much more effective than a signal hump by itself. Typical spacing should be 400 to 550 feet apart, and they should be located at least 200 feet away from intersections or sharp horizontal or vertical curves which restrict sight lines.

The location of the hump within the street is important. There must be sufficient room on either side of the hump for bicycles to pass without conflicting with by parked cars. Adequate drainage provisions must be included in the hump design so that it does not block a gutter or other drainage way within the street.

The typical installation of a speed hump ranges between $1,500 and $2,000.

Speed humps can be by far the most cost-effective RTM measure for reducing speeds on existing residential streets. While they often generate considerable opposition from drivers, fire departments and service agencies, speed humps have repeatedly been shown to be effective in reducing travel speeds by 5 to 10 mph on residential streets, and they are relatively inexpensive to install and maintain.

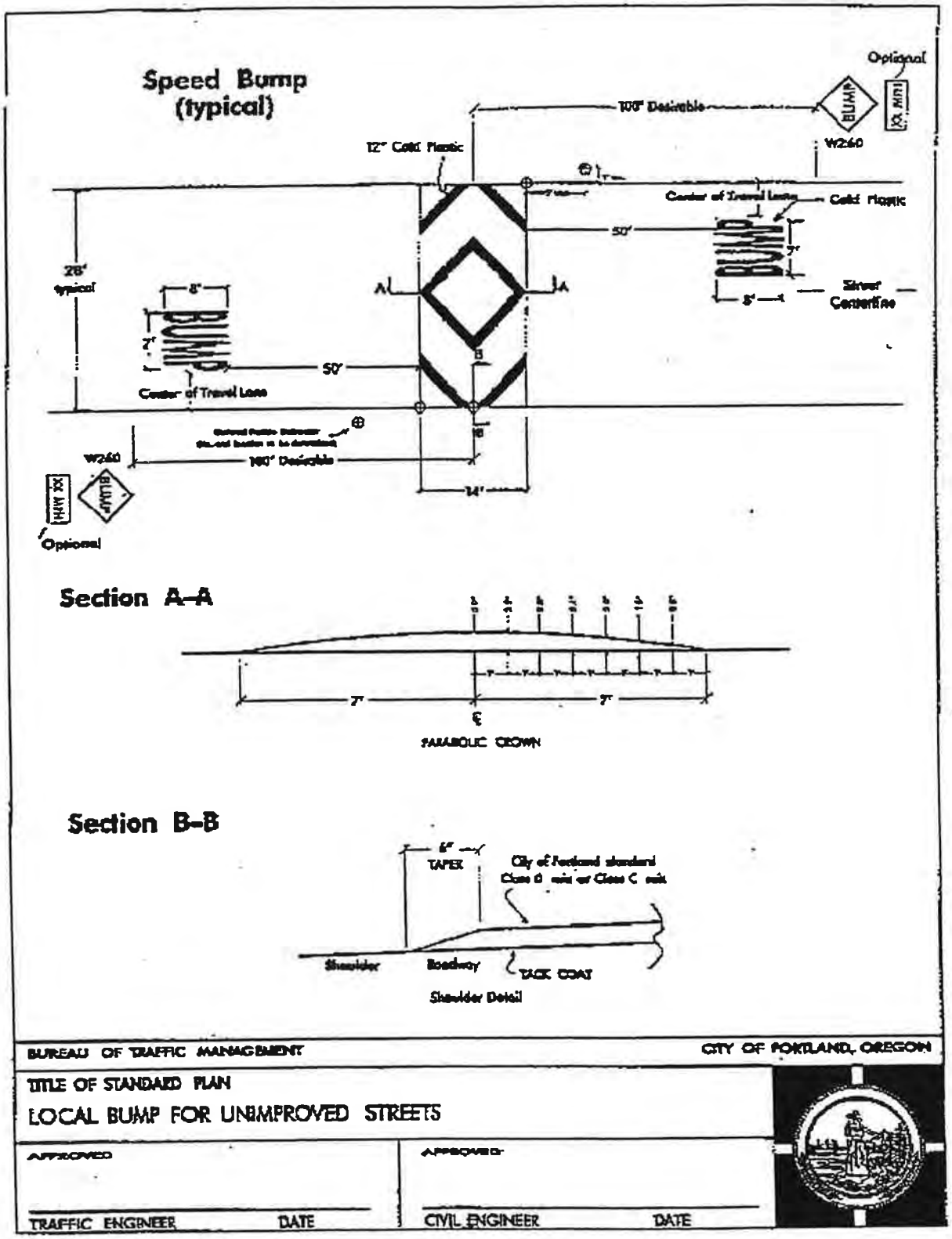


Figure 4-17. Portland's speed hump markings

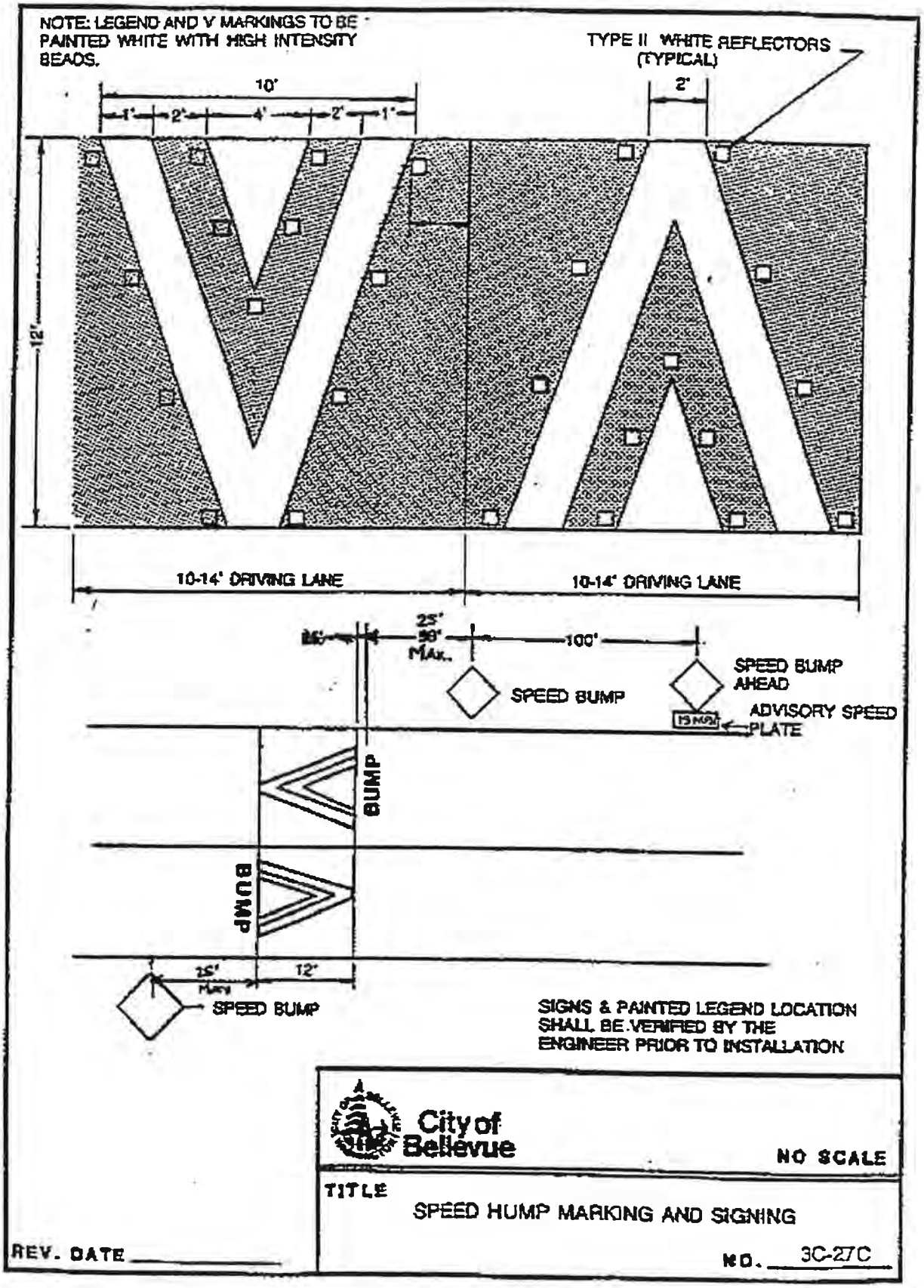


Figure 4-18. Typical signing and striping plan

Rumble Strips and Buttons

Rumble strips are patterned sections of rough pavement or row of traffic buttons placed across the driving lane used to alert drivers to a hazardous condition or the approach to another control device They have had some application for speed control in residential streets, although the noise generated by vehicles crossing the strips tends to create more resident protests than the speeding which they were intended to solve. Therefore, it is not recommended that rumble strips be used as a stand-alone device, but rather to call attention to some other device or warning sign.

Advance warning signs are often installed upstream of rumble strips. Additionally, a sign indicating the purpose of the rumble strip is placed adjacent to the rumble strip (i.e., stop ahead).

Rumble strips can be made from traffic buttons, grooved pavement, or brick paving blocks. Figure 4-19 shows a typical rumble strip made from traffic buttons. Rumble strips can be an effective attention-getting device in specific situations, particularly situations that exist all the time, such as a stop sign ahead, as opposed to school crossings which are in effect only during certain times of the day. Rumble strips are not generally effective at speed control or volume reduction.

Chokers

A choker is a constriction of the roadway at either an intersection or mid-block to constrain the width of the traveled path. Chokers have generally done little to effect traffic volume or speeds, but have been shown to improve pedestrian safety by shorting the length of crosswalks. Figure 4-20 shows a mid-block choker which is used as cross-walk.

Chokers also can be used to define the entrance of a neighborhood and to provide an opportunity for landscaping. Properly designed chokers look as though they have always been a part of the neighborhood's streetscape, rather than an "add-on" feature.

Visibility is a key design consideration and features such as advance warning signs, reflective channelization, reflectors on the curb, street lighting, and elevated landscaping should be used to improve visibility.

Figure 4-19. Rumble strips

Figure 4-20. Mid-block choker

Curb Extensions

Curb extensions can be used at entry points to neighborhoods to alert motorists of the residential character of the upcoming streets. They are also used to enhance pedestrian crossings at intersections by reducing pedestrian travel time and distance across the roadway. By narrowing the roadway for a relatively short distance, they force drivers to slow down and pay closer attention to the edges of the traffic lanes.

Curb extensions are often used in conjunction with landscape treatments to create protected parking spaces or mid-block crosswalks.

Entry Treatments

There are a wide variety of special treatments for entry points into residential areas which can be used to provide visual and tactile cues to drivers about the residential character of the neighborhood. These treatments usually combine aspects of textured and colored pavements, curb extensions, raised crosswalks or speed tables, a landscape theme and entry signage. The effectiveness of such treatments is limited unless the key elements (street narrowing and landscaping) are repeated at key points in the neighborhood. An examples are shown in Figures 4-21 and 4-22.

Median Slow Point

The City of Portland has developed a design for a median slow point which can be used to reinforce entry treatments in residential areas. The design shown in Figure 4-22 is based on narrowing the traffic lane to 10 feet by constructing a mid-block median and a marked pedestrian crosswalk. The design includes a 5 foot bike lane. The landscape treatment are entry points should be reproduced at the slow point.

Raised Crosswalk or Speed Table

Many jurisdictions have successfully used raised crosswalks to increase pedestrian safety and reduce traffic speeds. These can be located at intersections or mid-block. Essentially, they form an extension of the sidewalk and must have a smooth transition for pedestrians.

Figure 4-21a. Surry Downs entry treatment, Bellevue, WA

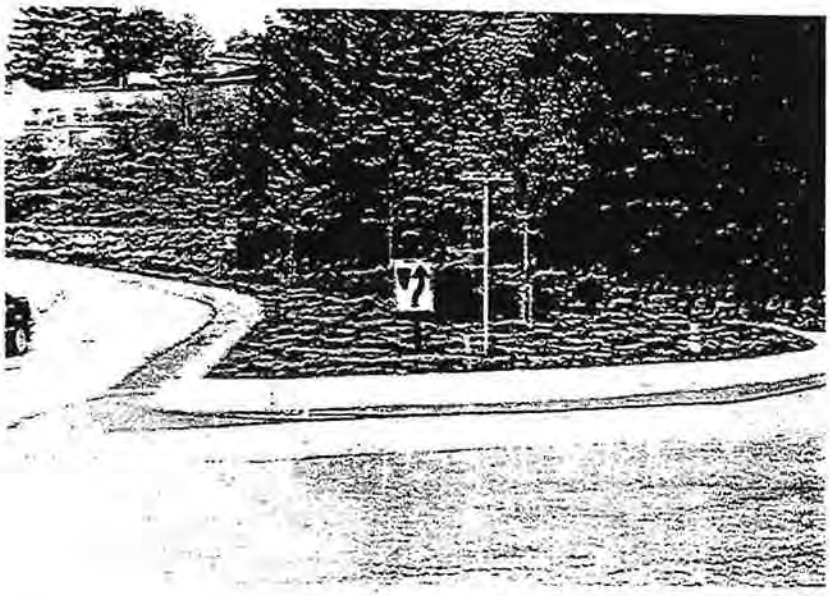


Figure 4-21b. Highland neighborhood, Portland, OR

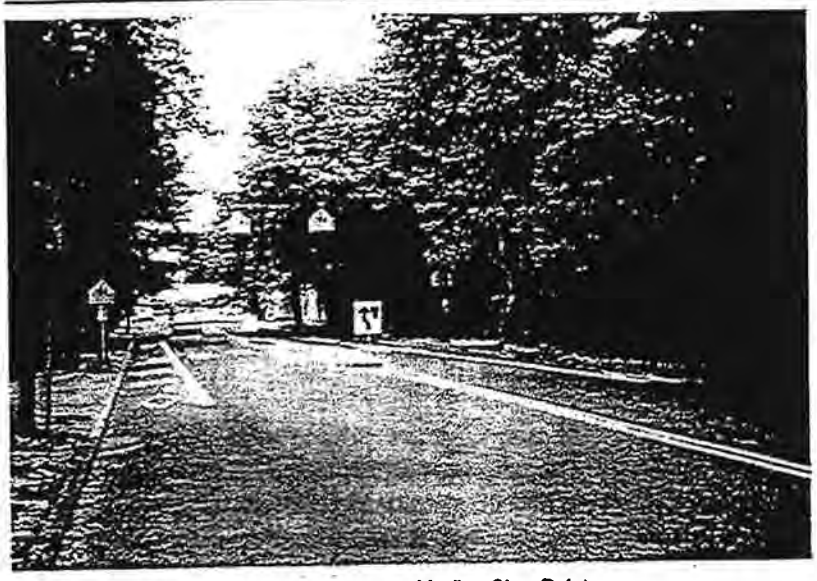


Figure 4-22. Median Slow Point

The raised crosswalk or speed table should have a six-foot parabolic approach transition raising the vehicles 3 to 4 inches above the nominal pavement. The flat section of the speed table should be 10 to 12 feet, and must be striped in accordance with *MUTCD* standards for crosswalks. Texture pavement may be used to further reinforce the speed table's effect on drivers perceptions, but the pedestrian area must be smooth enough to meet sidewalk pavement standards consistent with the Americans with Disabilities Act.

Raised Intersection

In limited instances, it may be desirable to elevate the entire intersection above the street grade to reinforce the nature and character of the area. Again, texture pavement treatments may be used. This measure is more commonly found in commercial areas with high pedestrian volumes rather than in low volume residential areas, but it may be applicable in a re-development area with an emphasis on neo-traditional design.

Chicanes or Serpentines

Chicanes or serpentines are devices that alter and slow the linear progression of a driver so that the automobile must shift to avoid an obstacle. Chicanes are generally staggered on opposite sides of the street at regular intervals. They are utilized often on long straight blocks. The devices used for construction may be curb extensions, planters, trees, barrels, fences or barricades (any device that is visible and imposing enough that vehicles will not drive over it). Parking areas are not considered chicanes, though they may have the same effect.

Chicanes are most effective when used in pairs of two or more sets placed 400 to 550 feet apart. This is illustrated in Figure 4-23 from the City of Seattle. As with other devices, visibility is a key design considerations and features such as advance warning signs, reflectors, arrow signs, street lighting, and elevated landscaping should be used to improve visibility.

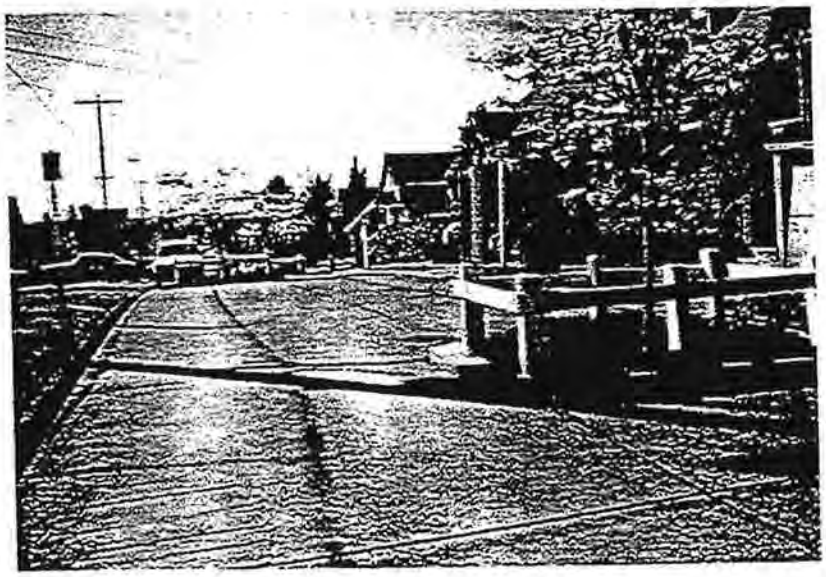


Figure 4-23. Chicane

Traffic Circles

Traffic circles or roundabouts are an effective and attractive technique for traffic restraint. They are round grade-separated areas placed in the center of an intersection. They are typically planted with shrubbery, flowers, or trees. Not only do they require traffic to slow down to get around them, but they also break the line of sight down a street so the driver cannot see any farther than the next traffic circle.

It is important to mark traffic circles well for night-time visibility with illumination, reflector buttons on the street surface, or reflectors on the sides of the concrete (if tall) or on low signs (if low circle). There is no generally accepted proper way to make a left turn at a circle; some jurisdictions allow left-turning vehicles to "short-cut" the intersection by turning in front of the circle, others, such as Boulder, Colorado, install a sign indicating that the vehicle is to drive around the circle to turn left. Cambridge, Great Britain, has marked the outer circle of its roundabouts with chevron tiles or blocks, which add both reflectivity at night and also point in the direction of travel.

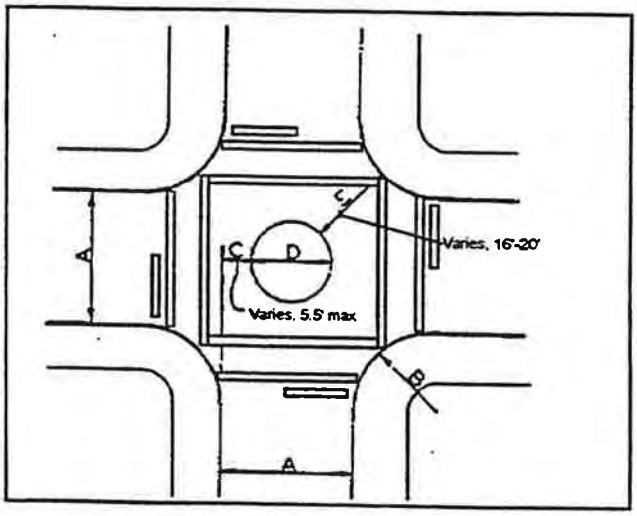
A well done traffic circle can be expensive to install; conversely they may be installed with very little cost. Some jurisdictions, especially when experimenting with them on a trial basis, may use tires, planters, sewer pipes (stood on end), guard rails, or wood barricades. Maintenance of the landscaping could be negotiated with the neighborhood residents, or adopted by a club. (See the following discussion on landscaping.)

The diameter of a traffic circle depends on the width of the intersection streets. The City of Seattle's design criteria are summarized below in conjunction with the schematic in Figure 4-24:

- The distance between a traffic circle and the street curb projection (off-set distance) shall be a maximum of 5-1/2 feet (dimension "C" in Figure 4-24).
- The width between a traffic circle and curb return shall be 16 to 20 feet ("E" in Figure 4-24).
- As the off-set distance decreases from the maximum 5-1/2 feet, the opening width shall increase from the minimum 16 feet.

The City of Portland, Oregon, has experience with two general types of traffic circles. Shown in Figure 4-25, the older type is a simple raised circular island. The new type of island, shown in Figure 4-26, consists of a slightly larger circular outer island "lip" with an additional concentric ring/curb. This new design also makes the middle of the island higher than the older design. Portland's experience with the older islands indicated that some drivers were not turning sharp enough and their vehicle's tires would rub into the island.

The purpose of the newer design is to make the island more conspicuous and make it more difficult for an errant vehicle to mount the traffic circle island. Instead, the larger initial curb/lip of the newer design helps drivers recognize the outer edge of the circle. Furthermore, if the curb of the traffic circle is struck, the newer design is better able to redirect the vehicle along its path and away from the center of the island.



Legend:

A	Street Width	D	Circle Diameter
B	Curb Return Radius	E	Opening Width
C	Off-Set Distance		

Optimum Criteria

Off-set Distance	Opening Width
5.5; max	16' min
5.0'	17' +/-
4.5'	18' +/-
4.0'	19' +/-
3.5' of less	20'

Figure 4-24. Traffic circle design criteria

In a report titled "Technical Evaluation Committee Final Report", prepared for the City of Portland's Neighborhood Traffic Management Program, dated January 1992, the following recommendations were made regarding Portland's traffic circles:

> Recommendations: As part of the City's periodic inspection of all traffic circle intersections, they should review the overall safety of their traffic operations including how vehicles go around the circles and if parked vehicles or fixed objects on the street curbs might constitute a significant hazard. In addition, an evaluation of sight distance for drivers on the minor street should be performed. Adjustments to the parking restrictions or removal/modification of objects that obstruct adequate sight distance should be made as appropriate.

Barriers/Restraints

Ranging from street closures and diagonal diverters, to chicanes and parking strip off-sets.

Street Closures

Street closures fall into two categories. Total closures using cul-de-sacs or half closures where traffic is limited to one direction usually outbound from a neighborhood, called semi-diverters. These devices can be installed temporarily by the use of barricades or guardrail or can be installed permanently with curb, gutter, sidewalk, and landscaping. Temporary closures allow the agency to test the design before permanent closures are constructed. The construction of permanent devices should generally follow the jurisdiction's design standards for residential streets in terms of curb, gutter, sidewalk, and landscaping. With adequate landscaping the street closure (full or partial) can look as if it were part of the initial street design rather than an added afterthought.

Street closures are most effective when added to a neighborhood in groups, in such a way to create a maze eliminating direct through travel. It is therefore important that proper signage be installed at the entrance to the street warning motorists that the street does not go through to the next intersection.

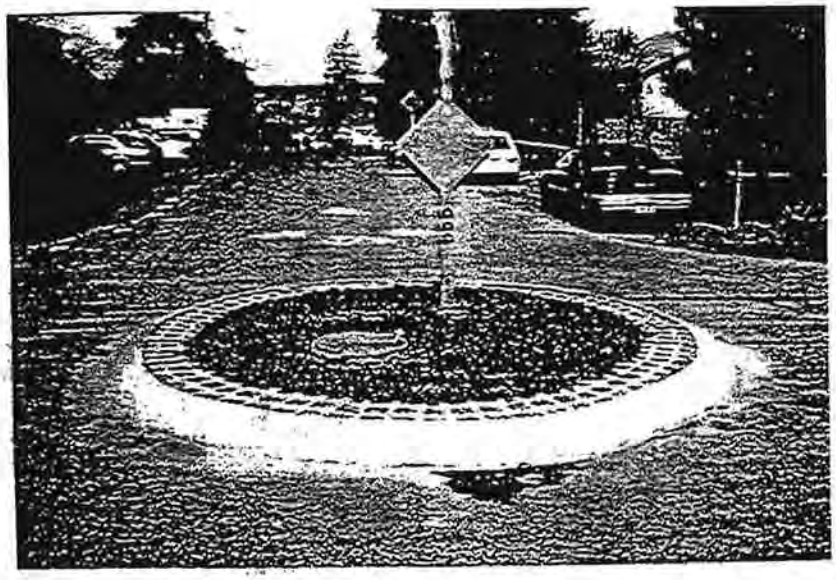


Figure 4-25. Portland's original traffic circle design

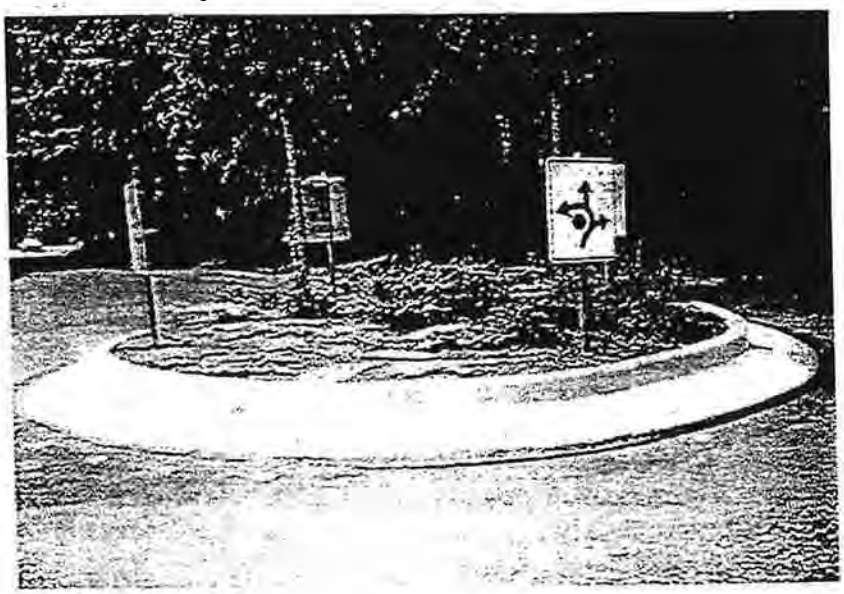


Figure 4-26. Portland's newer traffic circle design

A cul-de-sac provides closure of the roadway to through traffic in either direction. A cul-de-sac may be retrofitted to an existing street either at an intersection as shown in Figure 4-27 or at mid-block locations (Figure 4-28).

The primary fault with cul-de-sacs is the blockage of emergency and service vehicles and the inconvenience for neighborhood residents. It may be desirable to install bollards, mountable curbs, and traversable surfaces to allow emergency vehicle passage. The other challenge for the designer of a cul-de-sac is providing an adequate turn-around area; many existing residential streets do not have sufficient right-of-way to provide a 50-foot diameter circle for trucks to turn in.

Figure 4-27. Cul-De-Sac *(Vancouver, BC)*

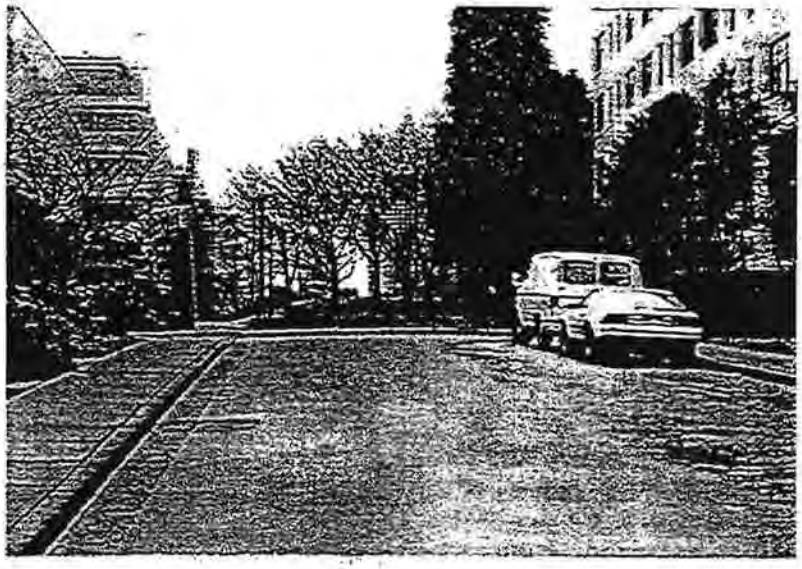


Figure 4-28. Mid-block street closure

Semi-Diverters

Semi-diverters are devices which bar traffic in one direction on a street while permitting travel in the other direction. In general, the roadway becomes one way at the semi-diverter while remaining two way for the remainder of the length.

Because semi-diverters block only half the street, they are easily evaded by motorists. This same property makes them a minimal impediment to emergency vehicles which can just go around the diverter in the wrong direction.

Semi-diverters can be constructed with curb and gutter, sidewalk, and landscaping as shown in Figure 4-29 or constructed of simple traffic barricades as shown in Figure 4-30. The temporary installation is a good way to test the effectiveness and acceptability of traffic diverters, but even the temporary device must be aesthetically pleasing and operationally safe.

Diagonal Diverters

A diagonal diverter is a barrier placed diagonally across an existing four-legged intersection. Its purpose is to convert the four-legged intersection into two unconnected streets, each making a sharp turn.

Diagonal diverters interrupt the continuity of a through street. Diagonal diverters are usually used in groups of two or more to create a maze within a neighborhood, eliminating cut-through traffic.

The radius of a diagonal should be consistent with the posted speed of the residential street and/or the speed

on the street reduced to accommodate the available turning radius. Advanced warning signs should be installed upstream (100 feet desirable) to alert the driver to the required turn.

Visibility is important and reflectors, directions arrow signs, street lighting or elevated landscaping should be added to improve visibility of diverters.

It may be desirable to install bollards, mountable curbs, and traversable surfaces to allow emergency vehicles passage across diagonal diverters.

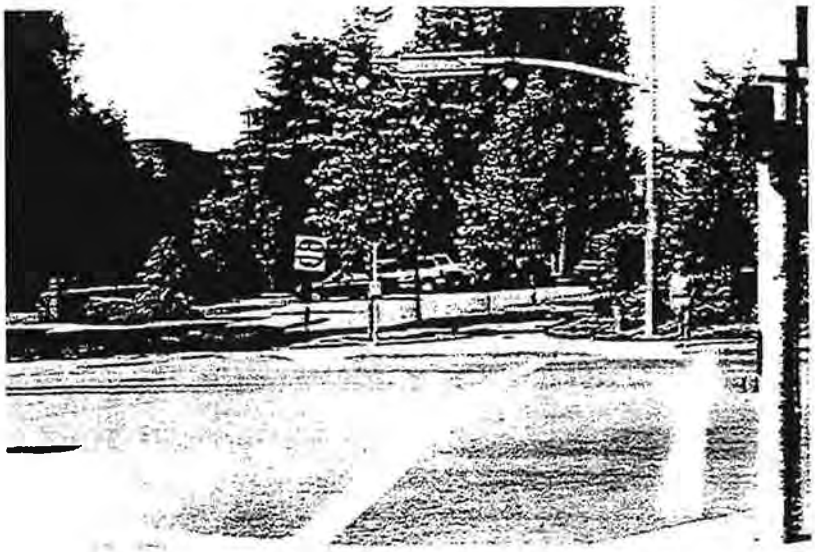


Figure 4-29. Semi-diverter — permanent installation

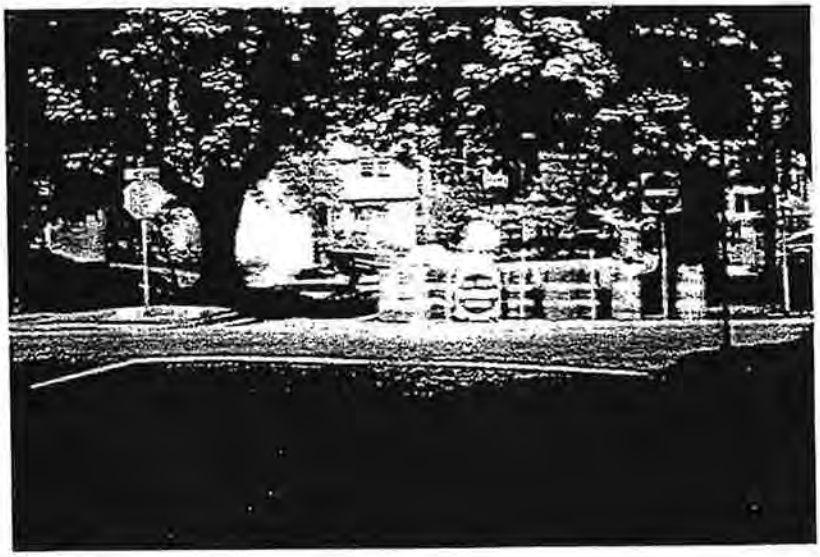


Figure 4-30. Semi-diverter — temporary installation

Median Barriers

Median barriers made by simply installing traffic curb down the center of a roadway, or by constructing wide landscaped medians, are a standard traffic engineering device that can be employed to prevent left turn entries to local neighborhood streets or to prevent through traffic from crossing from one neighborhood to another across an arterial

Advanced warning signs along with "Right Turn Only" signage and channelization should be installed with median barriers.

Endnotes and References

[1] For example, see *Stop Sign Evaluation, Final Report,* Portland Bureau of Traffic Management, Portland, OR, June 1992.

[2] *System Stop Signs*; Portland Bureau of Traffic Management, Portland, OR, December, 1991.

[3] *Local Area Traffic Management, Guide to Traffic Engineering Practice*, National Association of Australian State Road Authorities, Sidney, 1988.

[4] Wolfgang S. Homburger, Elizabeth A. Deakin, Peter C. Bosselmann, Daniel T. Smith, Jr., and Bert Beukers, *Residential Street Design and Traffic Control*, Institute of Transportation Engineers, 1989, page 105.

[5] David A. Nicodemus, "Safe and Effective Roadway Humps: The Seminole County Profile," *ITE 1991 Compendium of Technical Papers.*

[6] Graham Crampton, "Cost Benefit Analysis Applied to Local Traffic Calming Schemes," University of Reading (England), Department of Economics, Discussion Papers in Urban and Regional Economics, Series C, Vol V (1992/93), May 1992. Crampton also found average volume reductions of 23% for a sample of 30 RTM schemes, including the 17 road hump applications noted in the text.

[7] See Werner Briton and Harald Blanke; "Extensive Traffic Calming: Results of the Accident Analysis in 6 Model Towns;" *1993 Compendium of Technical Papers*, ITE Annual Meeting, 1993; and various articles in the *Journal of Accident Analysis and Prevention*, Vol. 24, No. 1, page 75-86, Pergamon Press, 1992.

[8] Several jurisdictions have augmented the MUTCD's stop sign warrants to be more responsive to traffic accidents on low volume streets. For example, see the *Stop Sign Evaluation, Final Report*, in note 1, and "Guidelines for Traffic Controls at Minor Intersections," Gian Aggarwal, Traffic Engineer, City of Vacaville, CA in "To the Editor," *ITE Journal*, November 1993.

[9] John LaPlante and Chester Kropidlowski, "Stop Sign Warrants: Time for Change," *ITE Journal*, October, 1992.

[10] In "Impact of Residential Street Standards on Neo-Traditional Neighborhood Concepts," *ITE Journal*, July 1994, Gordon Shaw discusses the differences among four widely used standard references for residential street design: AASHTO's *A Policy on Geometric Design of Highways and Streets (1990), ITE's Guidelines for Residential Subdivision Street Design* (1990), *Residential Street Design and Traffic Control* by Homburger et al, and *Residential Streets* sponsored by ASCE, ULI and the National Association of Home Builders. Shaw concludes that "In general, Residential Streets appears to be more akin to the philosophy put forward by the Neo-Traditional Neighborhood Design movement than the other design documents. At the opposite end of the spectrum, Guidelines represents the strongest statement of the traditional traffic engineering focus of residential design."

Figure 4-31. Diagonal diverter

[11] For example, see the section on stop signs in *State of the Art Report: Residential Traffic Management*; USDOT/FHWA, December 1980, pages 63 – 65, for a thorough discussion of previous studies.

[12] See note 1.

[13] LaPlante and Kropidlowski, *op. cit.*

[14] For example, see "Safety Effects of 30 Km/H Zones in the Netherlands," A. A. Vis, A. Dukstra and M. Slop; "Safety in Urban Areas: the French Program "Safer City, Accident-Free Districts," Anne Faure and Andre de Neuville; and "Safety Effects of Speed Reducing Measures in Danish Residential Areas," Ulla Engel and Lars Thomsen; reported in Accident Analysis & Prevention, Volume 24, No. 1, Great Britain, 1992.

[15] See Vis, Dukstra and Slop, note 14.

[16] For example, see Teun de Wit, "Dutch Experiences with Speed Control Humps," 1993 *ITE Compendium of Technical Papers*.

[17] Nicodemus, note 1

[18] *Guidelines for the Design and Application of Speed Humps*, ITE Technical Council Task Force on Speed Humps, Institute of Transportation Engineers, 1993.

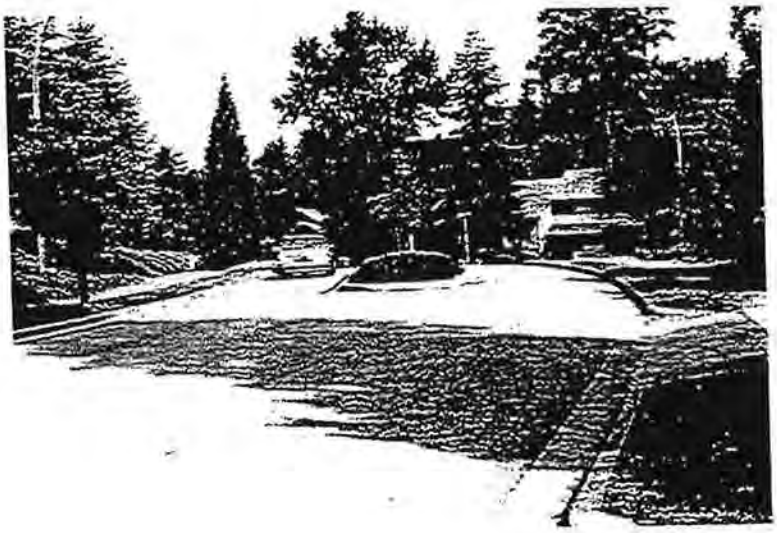


Figure 4-31. Median barrier

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Chapter 5.
Common Design Issues

Local jurisdictions face many common issues in selecting and designing of a Residential Traffic Management program or device.

A successful RTM program and its devices should be:

- Predictable: To ensure comparable types of traffic control devices over the entire transportation system.
- Based on Sound Engineering Standards: To ensure the safety of the public and limit the liability of the City.
- Equitable: To ensure a fair distribution of limited resources among the competing problems and among neighborhoods.
- Cost Effective: To get the greatest public benefit from the limited capital and maintenance dollars available to the City.
- Consistent: To ensure consistency with proven and accepted traffic engineering standards.
- Clear and concise: To be understood by the public, and easily administered by staff and officials.

Figure 5-1a. Speed Hump Striping Pattern

Figure 5-1b. Speed Hump Edge Treatment

Guidelines

While efficiency and cost-effectiveness are important, safety is the overriding requirement in the design of local streets and RTM devices. The entire "streetscape" should create a safe environment for motorists, bicyclists, pedestrians and residents. The needs of each competing user group are balanced with the overall all goals for the street. Each element of the streetscape should contribute to the goal of maximizing personal safety, rather than the speed of car travel.

While many examples of successful RTM devices exist, a list of "off-the-shelf" devices and design standards will not produce a successful RTM program. Each situation is unique, and all design elements must be reviewed on a given street when considering RTM measures. As a minimum, the following items should be reviewed by the design professional for each RTM installation:

Geometrics

- Alignment
- Turning Radius
- Horizontal and Vertical Curves
- Superelevation
- Major geometric features such as sidewalks, curbs, etc.
- Lateral separation of modes
- Roadway Width
- Sight Distances

Safety

- Channelization
- Illumination
- Signing
- Safety Zone (clearance of obstructions from traveled roadway)
- Crosswalk Locations

Utilities

- Water and Sewer
- Franchise Utilities (such as gas, power, telephone, etc.)
- Storm Drainage
- Location of Fire Hydrants

Design vehicles

- Local emergency vehicle characteristics
- Minimum design vehicle - bus, single unit truck or passenger car
- Public transit and school bus stops and routes
- Bicycles, wheelchairs and other non-motorized devices

Other

- Landscaping
- Pedestrians and Bicycles
- Handicapped Access
- Parking
- Mail delivery routes
- Emergency Access

The requirements for these elements can be found in the design references listed in Table 5-1.

A Policy on Geometric Design of Highways and Streets, (commonly referred to as the AASHTO Green Book), American Association of State Highway and Transportation Officials.

Manual on Uniform Traffic Control Devices (MUTCD), Federal Highway Administration.

Washington State Department of Transportation:

- *Sign Fabrication Manual*
- *Standard Specifications for Road, Bridge, and Municipal Construction*
- *Standard Plans* for Road and Bridge Construction
- *Local Agency Guidelines*
- Local Supplements to the State's Standard Specifications and Standard Plans (varies by jurisdiction)

Table 5-1. RTM Design References

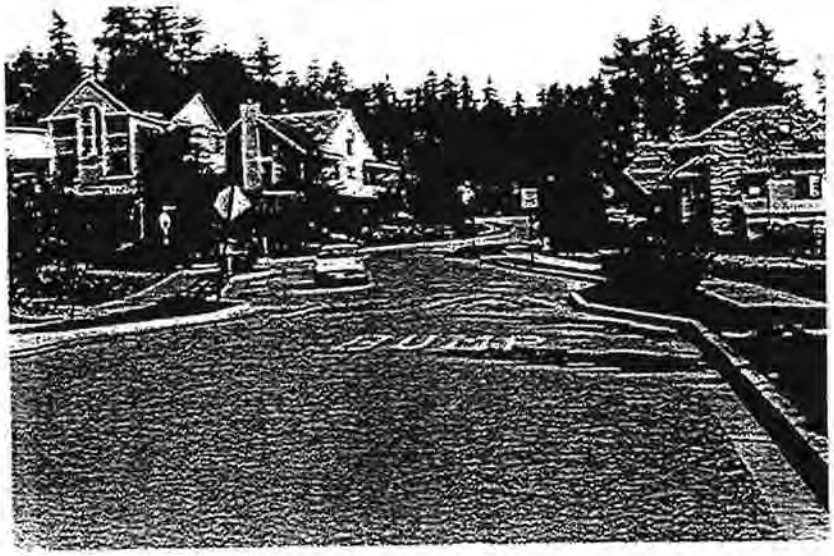

Figure 5-2 Visibility is a key design issue at an RTM device

Design Aspects of RTM Devices

This section discusses design issues related to specific RTM devices. Some common issues are:

- *Visibility.* Devices should be easily visible during day and night. Reflectors, buttons, highly reflective paint, or illumination should be used as appropriate to ensure visibility. Additionally, RTM devices should not be placed were drivers do not have adequate stopping sight distance for the desired deign speed.

- *Signage.* Advance signs should warn motorists of upcoming RTM devices and, to the extent possible, guide the motorists' response to such devices. For example, a curve sign should be placed upstream of diagonal diverters. A typical RTM warning sign is shown in Figure 5-3.

- *Streetscape.* RTM devices should blend naturally into the streetscape and enhance the appearance and "feel" of the street. They should alert drivers that they are in or entering a residential place.

- *Design vehicles.* RTM devices should be designed to accommodate emergency service and other large vehicles at an acceptable speed.

- *Maintenance.* As with any municipal project, the longer term maintenance needs should be anticipated in the design process and minimized to the extent possible. Some jurisdictions contract with the neighborhood to maintain plantings or simply eliminate planting and landscape in the absence of a willingness on the part of residents to participate.

- *Parking.* On-street parking in residential areas creates a sense of activity; some jursidictions encourage on-street parking for this reason. However, in some instances, on-street parking also creates sight line restrictions which may be unsafe for drivers who are going too fast. Diagonal parking in selected areas can be used to slow traffic flow, since motorists must be alert to cars backing out at any time. Examples of parking options are given in Figure 5-4.

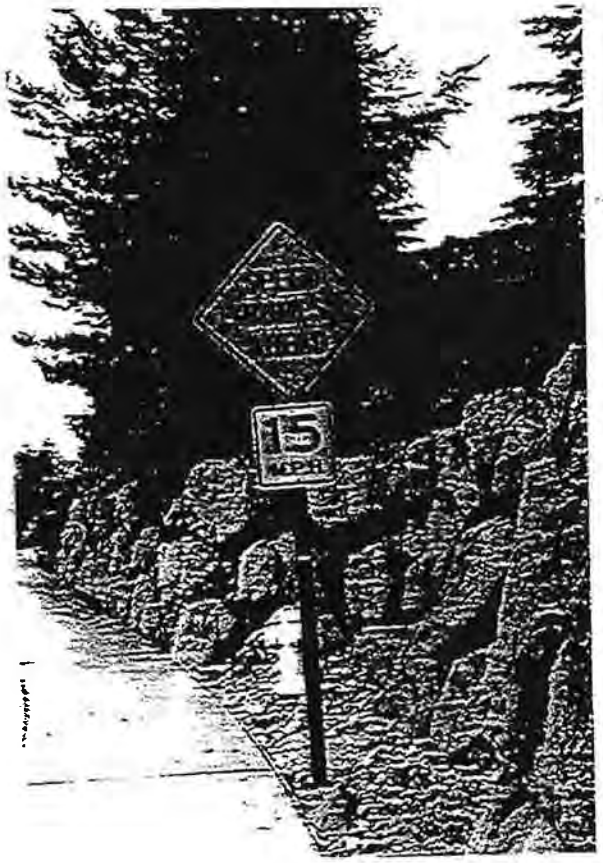

Figure 5-3. Advance warning sign

- *Speed control.* RTM devices should be located and designed to limit speeds in residential areas.

Landscaping

Neighborhood residents often insist on attractive landscaping as a component of RTM devices. Landscaping can enhance the effectiveness of traffic control devices and add to the living quality of the neighborhood. Figure 5-5 shows two approaches to landscaping traffic circles in the City of Seattle. The first, with a tree and well-established vegetation, contributes to the character of the neighborhood and reinforces the circle as an obstacle requiring low speeds to circumnavigate. The second, anchored by reflectors on a sign post, attracts little extra attention as evidenced by the dents in the guard rails and wheel marks on the curbing around the circle.

When planning landscaping, consider the following issues:

- Does the landscaping block vehicle and pedestrian sight lines?
- Does the landscaping hide pedestrians?
- Does the landscaping attract the driver's attention and induce the driver to negotiate the circle at low speed?
- Does the landscaping block illumination? The site should be visited at night to review the illumination and looking for shadows.
- How will the landscaping be maintained? Is irrigation required?

Many cities use a team approach where the neighborhood and city share the costs of installation and maintenance.

Figure 5-4a. Parallel parking on one side of the street

Figure 5-4b. Parallel parking on both sides of the street

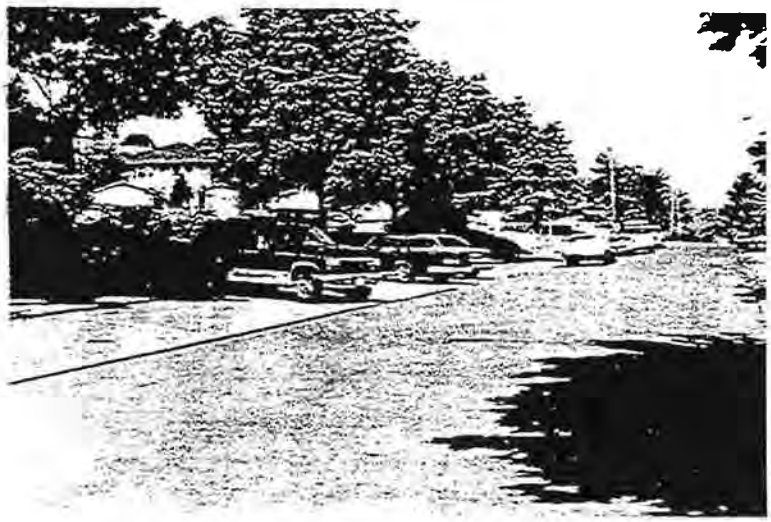

Figure 5-4c. Diagonal parking on one side of the street.

Landscaping is usually handled in one of three ways:

1. The City buys, installs, and maintains the landscaping through the local parks department, street maintenance staff, or via contract with private landscape maintenance firm. King County, Washington, generally retains responsibility for maintaining their RTM devices.

2. The City buys and installs the landscaping, but the residents are responsible for maintenance. The City usually requires a maintenance agreement before the landscaping is installed. Often the City will train and advise the residents with this task. If the landscaping is not maintained as agreed, the City will remove it and pave or otherwise surface the area. This approach has been used extensively in the City of Seattle with good results.

3. The residents purchase, install, and maintain the landscaping through donations, a Local Improvement District (LID), or other community funding sources. Sometimes a local plant nursery or community club do this as a community service.

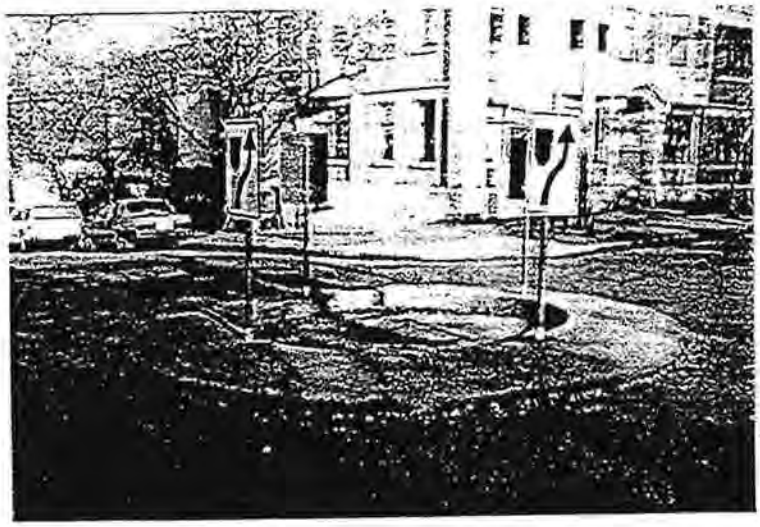

Figure 5-5a. Traffic circle with no landscaping

Figure 5-5b. Traffic circle with moderate landscaping

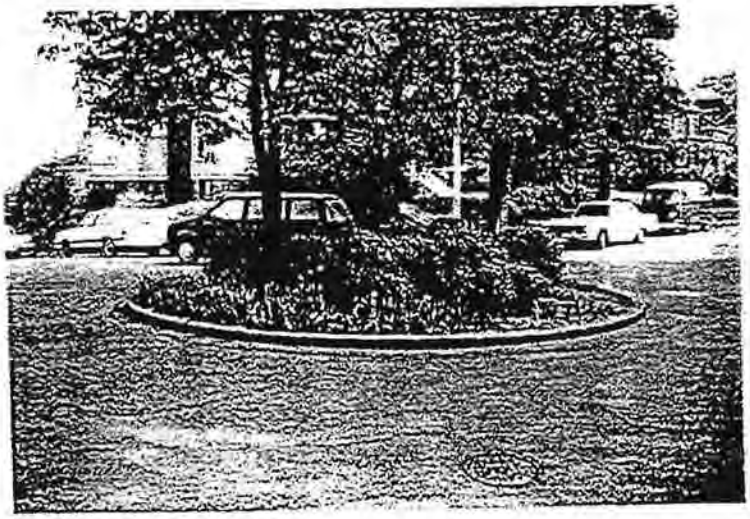

Figure 5-5c. Traffic circle with trees, shrubs and flowers

Concerns of Emergency and City Service Agencies

Any neighborhood traffic control plan should involve emergency and city service personnel from the very beginning. Police and fire departments are concerned about their response times to all parts of a neighborhood. City maintenance personnel are concerned with storm drainage, street

cleaning and repair, and snow plowing in colder areas. It is much more cost effective and politically acceptable to address these issues at the onset of any program, instead of solving a problem after it has happened.

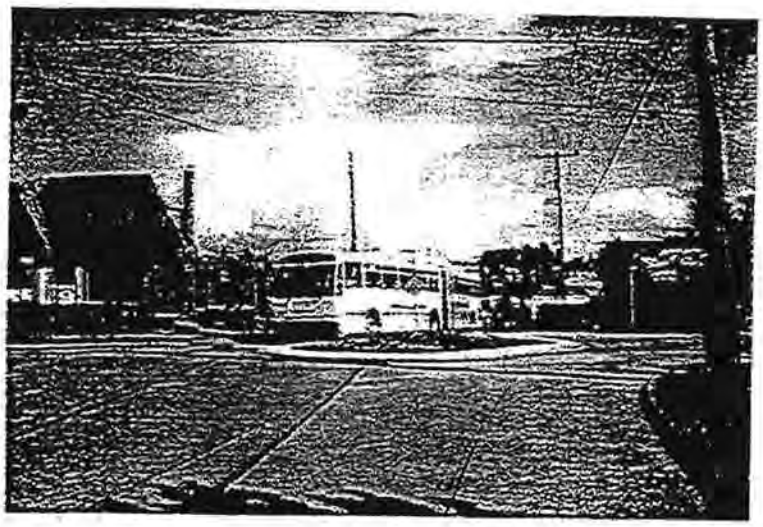

Figure 5-6. Articulated Bus at Traffic Circle

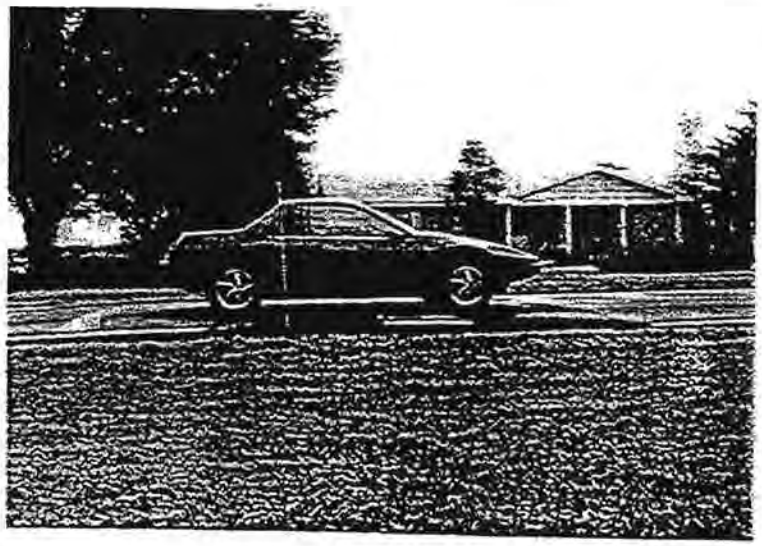

Figure 5-7. Speed hump test

Fire and EMS

The local Fire/EMS Departments will often oppose any physical methods of neighborhood traffic control. They are opposed to anything that slows, or is perceived to slow, their response time. Working with these departments early can often yield acceptable solutions. The Fire Department may prefer one physical device over another, or will identify a particular route that is heavily used and no devices should be placed on that route. By working closely and early with the Fire/EMS personnel, problems can be avoided, negative impacts be reduced, resulting in acceptable measures that are effective in remedying the original traffic complaint.

The Portland, Oregon Fire Bureau uses a "pro-active" approach to working with the Portland Department of Transportation on traffic calming projects. First, they use their fire trucks to design standard templates for RTM devices to ensure acceptable design standards. For example, Portland is experimenting with longer, lower speed humps which can be negotiated by fire trucks at 25 to 38 mph. Second, the bureau developed maps of primary response routes, where the use of RTM devices are limited. The City participates in discussions with staff and elected officials about trade-offs between emergency response times and traffic control on such routes. Third, and perhaps most important, fire department staff visit each site proposed for RTM actions and assist the City in finding solutions which are acceptable to city departments and local residents.[1]

The City of Portland, OR, conducted a series of tests of the effects of speed humps on EMS vehicles.[2] The City's Bureau of Traffic Management has a video tape of these tests, clearly showing the reactions of the vehicles to traversing the humps at various speeds. Similar tests have been conducted by the City of Bellevue, WA; information can be obtained from the city's Public Works Department.[3]

Some of the concerns typically expressed by the fire departments:

Total Road Closure: Fire departments are concerned about situations where a fire truck might find itself on one side of a closure with the emergency on the other side and no way for the truck to reach it. For large fires, fire departments often approach the location from

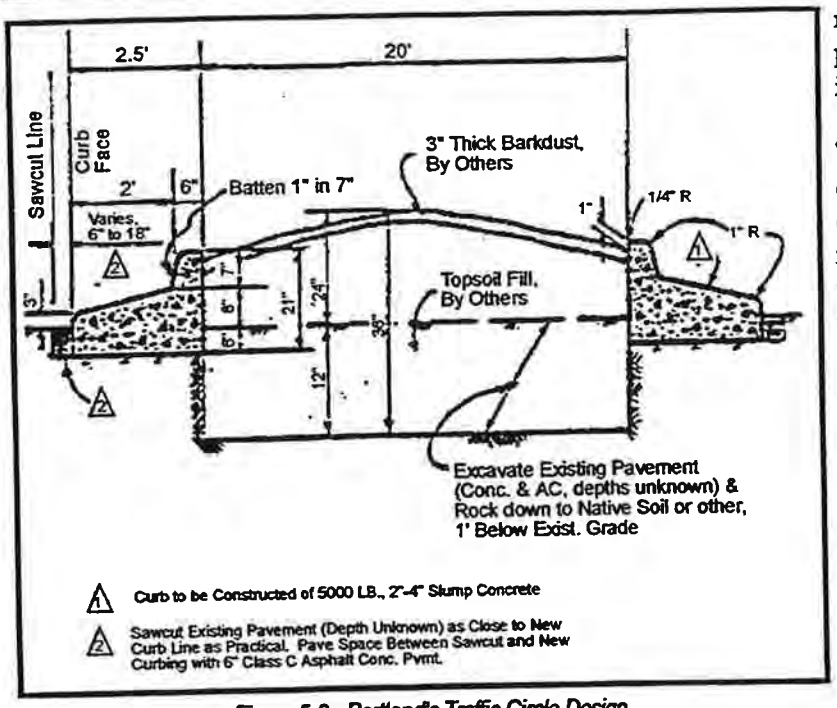

Figure 5-8. Portland's Traffic Circle Design

many directions. A total closure will prevent or hinder such an approach, although traversable barriers which allow for passage of emergency vehicles can often be an acceptable compromise.

Diagonal Diverters, Medians, and Forced Turn Channelization: Although these devices are not as restrictive as total closures, these devices pose some of the same problems for emergency vehicles. They may increase response times by forcing emergency vehicles to take a less direct route.

Semi-diverters, Chicanes, Curb Extensions and Chokers: Although these physical barriers do allow emergency vehicles to pass (in the case of semi-diverters, the emergency vehicle may enter in the wrong direction), they do slow the vehicle and increase response time.

Many fire department are concerned with getting their large trucks through tightly confined spaces. Waiting vehicles may cause the EMS vehicle to stop while the other vehicles clear the RTM device, thus increasing response time. Illegally parked cars, near these devices may also block the path of larger fire trucks.

EMS personnel say that the tight turns required to go through semi-diverters and chicanes can cause undo movement to critically injured patients and even cause additional injury.

Traffic Circles: Although properly designed traffic circles will let emergency vehicles pass at a relatively higher speed than other physical devices, they do slow response times. Additionally, vehicles parked illegally or too close to traffic circles can block larger emergency vehicles. Mountable curbs on the traffic circle will help the emergency vehicles get through a blockage, but to go over the curb will require very slow speeds, thus slowing response time.

The radius of a traffic circle, and the gap between the circle and the street curb, directly affect the speed and ease with which emergency vehicles can pass. Local emergency services personnel should be consulted to determine the best radius for their equipment. Temporary circles should be set up with cones, and the emergency response groups should conduct test drives to see how their vehicles react to the circles. Experiment to see what works best for both the neighborhood and the response teams.

Speed Humps, Raised Intersections and Special Pavement Treatments: Although these devices provide the greatest access to emergency vehicles, they force the vehicle to slow to about 5-15 mph for short distances. Fire departments say that speed humps at any speed tend to dislodge equipment on the trucks and may cause discomfort and/or injury to personnel riding the vehicles.

Portland, Oregon, has prepared a video tape of their different fire trucks and EMS vehicles going over various speed humps at different speeds. This video helped the City determine the best hump design and helped emergency personnel establish their safe travel speeds over the humps.

Fire departments also mention an increased maintenance costs due to damage caused by going over mountable curbs and speed humps, although no studies

have been performed to substantiate this claim. The fire chiefs interviewed for this guidebook have not experienced these added maintenance costs in their departments.

Also, EMS personnel say that the bump caused by speed humps might cause additional pain or injury to critically ill patients. However, there have not been any studies to document this affect.

Police

The local police department will also be concerned about how physical traffic control devices affect response time. Barriers to through traffic make it more difficult for police cars to patrol an area. At the same time, police departments are concerned about traffic safety and will support prudent measures to improve traffic flow and safety in neighborhoods.

Transit, Refuse Collection and Delivery Vehicles

RTM devices must allow reasonable passage of delivery and refuse collection vehicles of various sizes. This can be handled through proper design and attention to turning radiuses of various trucks. Public transit and school buses present less of a problem, since they mainly run on collector and arterial streets, but the potential location of RTM devices should be checked with the transit agency and school district in order to minimize interference with their routes. Access for delivery trucks and large moving van must be taken into account in the location and design of RTM devices as well.

Maintenance

Many of the traffic control devices may interfere with existing drainage patterns, hydrant locations, sewer manhole access, street cleaning, snow removal and other street maintenance functions. By working with the maintenance department, the design can be adjusted to minimize conflicts, and maintenance personnel can gain a better understanding of the devices and their purposes. Additionally, the cost to maintain the traffic control devices will need to be accounted for in the annual maintenance budget.

What the research says about RTM and EMS

A recent article by Zaidel, Hakkert and Pistiner in *Accident Analysis and Prevention Journal*[4] supports the trade-off of the benefits of RTM devices versus perceived impacts on emergency services. The authors conducted an extensive review of existing literature and an international survey of 23 respondents in 13 countries with years of experience on 100's of speed humps. For properly designed speed humps, such as the TRRL trapezoidal humps, they found no reported cases of damage, increased risk or operational difficulties associates with EMS in communities where humps were installed. "It seem that the objection of these services are a matter of policy and that they are quiescent after the humps are in place."[5]

The authors reported that potential objections on the basis of discomfort, damage, access or delay are more theoretical than real. More problems are caused by congestion, potholes and erratic drivers on high volume arterial streets than by speed humps on residential streets. To the extent that humps and other speed controlling measures reduce accidents, particularly serious pedestrian injuries, there will be a net gain to the EMS effectiveness overall, and the potential availability of EMS vehicles areawide.

Sharing the Road

Many people in the U.S. believe that streets belong to the drivers and their vehicles. The 36-foot wide typical suburban residential street with curbs and sidewalks says to motorists, "This is your space." In this environment, safety requires that cars and people be kept separated, even in residential areas.

The European *woonerf* concept[6] challenges this American perception by demanding that motorists in residential areas safely share the local street with its residents. *Woonerf* roughly translates as "living yard" and residents in such areas treat the street as a paved extension of their front yard. Drivers are cautioned through visual cues that they are in a residential space where they must share the space with bicycles and pedestrians.

Meandering streets, pedestrian activity and narrowed traveled ways also increase the drivers' attention levels in residential areas. Interrupted sight lines (to 300 feet), changes in pavement textures, angle parking and raised crosswalks force drivers to watch where they are going,

There is also a large body of research which suggests that increasing the safety of a car or road simply encourages the driver to take greater risks.

Drivers are willing to take a certain amount of risk in exchange for the benefit of faster speeds. This risk is added to safety limits of the car or road. **The new safety features also lull the driver into a new sense of security and vigilance, concentration and attentiveness are reduced.**[8]

and cause them to maintain lower speeds. Such streetscape actions force drivers to take responsibility for their actions, increases their attention levels and adds to the safety of the residential street environment.

This approach is reinforced by research findings in Australia.[7] Kenworthy argues that the most successful measures in reducing the road toll (fatalities) are those which "force a level of car use in a direction away from the available limits of the car and its driver." In other words, force drivers to drive at speeds and in a manner which are below the (ultimate performance) limits of the car and road.

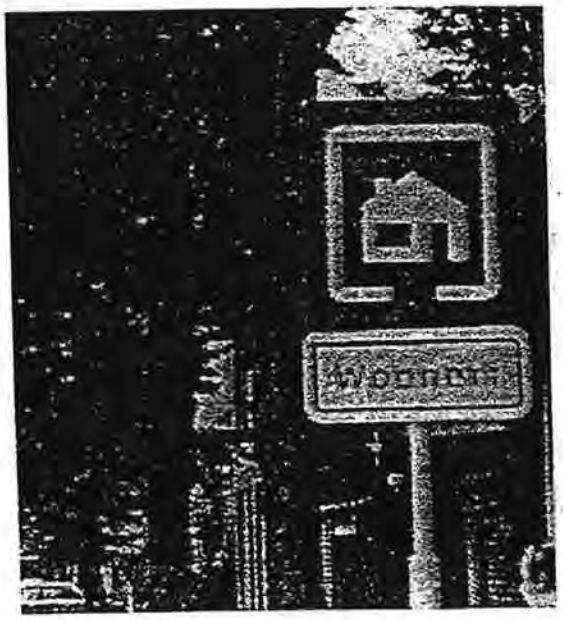

Figure 5-9. Woonerf sign

Do's and Don'ts of the Design Process

Do

☺ Install temporary traffic control devices and monitor them for a period of time before installing the permanent device.

☺ Have an organized program including public involvement with plans and policies approved and supported by the local city council/government.

☺ Involve the local service agencies, including fire, police, and emergency medical service personnel, from the start.

☺ Consult with fire department and EMS personnel to develop the preferred design, particularly with speed humps and traffic circles. Set up traffic circles with cones and have the fire trucks and other emergency vehicles drive around them; this will help determine what radius is best for the types of emergency vehicles found in different areas. The same process can be used in the design of speed humps.

☺ Review traffic patterns in the neighborhood as a whole. Avoid solving the problem on one neighborhood street by just shifting the traffic to another neighborhood street.

☺ Make certain that all signing and channelization is in accordance with the Manual on Uniform Traffic Control Devices (MUTCD), the State's Sign Fabrication Manual, and the AASHTO Policy on Geometric Design of Highways and Streets.

☺ Check sight distances for vehicles, pedestrians, and bicyclists. Sight distance is to meet the requirements of AASHTO Policy on Geometric Design of Highways and Streets.

☺ Become familiar with RTM devices in other communities and assemble references so that residents can be directed where to see them.

☺ Decide on a safe design speed beforehand and in consultation with neighborhood residents.

☺ Check sight distances by visiting the site before and after installation. Do parked cars obstruct sight distances? Does landscaping or other features obstruct sight distance?

☺ Review the illumination at night. Are additional street lights needed? Does landscaping block the light? Is there a shadow on one side of a median or traffic circle that might hide pedestrians from view?

☺ Review the channelization during the day and night. Is it clear when approaching from all directions? Can it be seen at night? Watch the traffic, is the driving public confused by the signing and channelization? Make adjustments when needed.

☺ Review the site for utility conflicts. Is there a fire hydrant? Does it need to be moved? Are there existing utilities in the way?

☺ Check the storm water drainage. Will the storm drain system need to be moved or revised? Can the runoff get through or around the device?

☺ Review the on-street parking. Will parked cars block access of emergency vehicles through or around the proposed neighborhood traffic control devices? Add additional no parking zones where needed. Additional enforcement of parking restrictions may be required to keep the traveled path clear.

Don't

☹ Don't install neighborhood traffic control devices without a well-engineered program supported by the local governments and public.

☹ Don't install neighborhood traffic control devices on arterial streets. Typically, physical devices are not installed on streets with volumes greater than 3,000 vehicles per day, or with posted or prima-facie speeds of greater than 30 MPH.

☹ Don't install neighborhood traffic control devices on streets without curbs unless supplemental features are included to keep vehicles within the traveled way.

☹ Don't install neighborhood traffic control devices on streets with grades of greater than 10 percent.

☹ Don't install neighborhood traffic control devices on major truck routes.

Figure 5-10. Partial Street Closure (test installation)

☹ Don't install neighborhood traffic control devices on primary emergency routes. Contact local fire, emergency service agencies, and police departments to determine these routes. Secondary access routes should be considered on a case-by-case basis.

☹ Don't install neighborhood traffic control devices on curving, winding roads with limited sight distance unless reduced speed limits and adequate warning signs are used in conjunction with the device.

☹ Don't place neighborhood traffic control devices in front of driveways.

☹ Don't neglect to check for conflicting utilities.

☹ Don't install physical devices on adjacent parallel routes as this prevents or hinders emergency response. For example, Portland, OR, has a written policy against neighborhood traffic control devices on both of two adjacent parallel routes.

Endnotes and References

[1] The City of Bellevue Fire Chief has indicated that his department opposes any roadway restriction that left less than 22 feet clearance (two 11 foot lanes).

[2] See *Emergency Service*, A Technical Report compiled by City of Portland (OR) Bureau of Traffic Management, June 1991.

[3] Karen L Gonzalez, "Neighborhood Traffic Control: Bellevue's Approach," *ITE Journal*, May, 1993, p. 43-45.

[4] D. Zaidel, AS Hakkert and AH Pistiner; "The Use of Road Humps for Moderation of Speeds on Urban Streets," *Accident Analysis and Prevention Journal*, Vol. 24, No 1, p. 45-56, 1992.

[5] *Ibid.*, page 53.

[6] See Rodney Tolley, *Calming traffic* in residential areas, (Brefi Press, Tregaron, Dyfed, Great Britian, 1990) Chapter 4, for a good description of the woonerf concept.

[7] Reported in *Traffic Calming: The Solution to Route 20 and a New Vision for Brisbane*; Citizens Against Route Twenty; Ashgrove, Queensland, Australia, 1989, page 12.

[8] *Ibid.*

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